ENGINEERING CONSTRUCTION WEEKLY

W-HILL PUBLISHING COMPANY, INC. · TWENTY-FIVE CENTS, FIVE DOLLARS PER YEAR

AUG 27 1937

Engineering NEWS-RECORD

August 26, 1937

BRIDGES · IRRIGATION · FLOOD CONTROL · FOUNDATIONS · DAMS ·

HWAYS · WATERWORKS · STR S ·

UNIVERSITY OF MICHIGAN
GENERAL LIBRARY
ANN ARBOR MICH 2-C

Use of BYERS WROUGHT IRON marks new trend in grade crossing elimination

● Bridge deck and railings of Ivory Avenue Bridge, St. Louis, carrying tracks of Missouri Pacific Railroad, were made of Byers Wrought Iron.

● The grade crossing elimination program has brought the interesting combination of beauty and utility through the use of wrought iron.

Bridge railings need no longer obstruct vision. The use of Byers Wrought Iron angles, bars and pipe, as illustrated, makes a low-cost, light-weight railing of artistic value, with ample visibility and proved durability. Where locomotive blasts corrode the bridge overhead — wrought iron blast plates offer complete protection. And in the bridge illustrated, ballast deck plates of wrought iron save height and protect the structure from corrosive brine drippings.

Railroad and highway engineers are to be congratulated on their work in combining beauty and utility. Bridges such as this mark a new trend in design and construction.

Any of our Field Engineers or our Engineering Service Department in Pittsburgh will be glad to give you more of the details about this and other bridges recently built with Byers Wrought Iron. Also ask for the illustrated report, "The Use of Wrought Iron in Bridge Construction." A. M. Byers Company. Established 1864. Pittsburgh, Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

BYERS GENUINE WROUGHT IRON

Tubular and Flat Rolled Products

Specify Byers Genuine Wrought Iron Pipe for corrosive services and Byers Steel Pipe for your other requirements

What about Old Blue?

IT HAPPENED one day last summer. We were speeding northward on a highway that skirts the eastern foothills of the Rockies. We had just crossed a state line when one of the party, a well-known contractor of those parts, exclaimed. "Whoa! Wait a minute. There's Old Blue's grave."

So we stopped. A small barbed wire enclosure, fitting corral for an equine spirit, a pile of stones, a white painted wooden head-board, bearing the hand-lettered epitaph, "Erected to the Memory of Old Blue, the Best Old Cow Pony That Ever Pulled on a Rope. By the Cow Punchers of the 7XL Outfit. Rest in Peace."

That was all. To the west the distant mountains against a blue, blue sky. Everywhere else the endless sweep of the rolling plains, broken only by a nearby clump of trees and its windmill. And Old Blue's grave.

What about Old Blue? Who was Old Blue? Why the memorial? The contractor knew only that many years ago, when he built the railroad through that country, Old Blue's grave already was a landmark in a vast open land. Next day this writer drove more than a hundred miles to revisit the spot with his camera. And often since his thoughts have turned to Old Blue in his lonely corral.

So what?

Well, how many travelers, do you suppose, coming from most everywhere, whiz unknowing past Old Blue's grave? Lacking so well-informed and thoughtful a guide, they miss it altogether. But maybe, if they knew, they would be just as interested as was this writer. Maybe this link with a bygone day would be one of those souvenirs that make travel so stimulating and a holiday so much more than just another "good time."

NORTH, south, east and west, the highways are lined with comparable shrines of interest. Many of them are just sites; no man-made work remains. But on that ground may have been enacted scenes in the drama of a nation. And the motor car and the modern highway every year bring close to them hundreds of thousands of our people. All these might enjoy their inspiration, provided only that they knew of them.

This does not imply that nothing at all is done to this end. Many of the states, many civic and historical societies have done much to make the highways something more than arteries of traffic. They have set up many markers and tablets which add to the interest of travel and the delight of a holiday.

But some states have done better than others. Montana, for example. Out there the Highway Department sets up markers designed to be useful rather than monumental. It makes them plenty big and provides room for the motorist to stop long enough to read them. The pretentious granite monuments and bronze plates so often used are likely to be inaccessible and difficult to read; other forms of markers are too small and inscribed with solid rows of capital letters—always difficult to read quickly. Often they are so dirty as to be illegible.

NOT LONG AGO this writer drove through some of the most historic country east of the Alleghenies. Now and then, from the corner of his eye, he caught glimpses of markers that he knew must be of surpassing interest. But even had he seen them in time, it would not have been possible to stop in traffic and read them.

The public highway investment pays for itself in many ways. Of the economic values this page often has spoken. But one of its greatest social returns is the opportunity it offers for our people to learn more of their country and of each other. To many of the states this "tourist appeal" is of very real economic value as well.

But if we are going to realize on it, we must overlook no chance to inform the visitor and to remind the home-folks of the cultural riches that line their highways. And in that job the highway departments should have a keen interest, either as principals or through cooperation with other appropriate agencies.

Thousands of people would like to know more about Old Blue.

Willard Chevalier

ENGINEERING NEWS-RECORD

Published every Thursday. Vol. 119. No. 9. Price 25c per copy. Subscription, domestic, Canada, Mexico, Central and South American countries, $5 per year. All other countries, $9 a year or 36 shillings. Entered as second-class matter October 29, 1936, at the Post Office at Albany, N. Y., under the act of March 3, 1879. Printed in U. S. A. Cable address "McGrawhill New York." Member A.B.P. Member A.B.C.

Copyright 1937 by McGRAW-HILL PUBLISHING COMPANY, Inc.

Editorial and Executive Offices: 330 West 42d St., New York. Publication Office: 99-129 N. Broadway, Albany, N. Y. Branch Offices: 520 N. Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, W. C. 2, England; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

JAMES H. McGRAW, JR., President — HOWARD EHRLICH, Exec. Vice President — JAMES H. McGRAW, Honorary Chairman
WILLARD CHEVALIER, Vice President — B. R. PUTNAM, Treasurer — D. C. McGRAW, Secretary

Fleet owners of the Koehring Trail - Dump are hauling dirt for road work at exceptionally low maintenance costs. Continuous operation at high speeds means more dirt per hour for greater profit per job. Many outstanding time - saving features have established the Koehring Trail-Dump as a highly profitable dirt hauling unit.

KOEHRING TRAIL-DUMP

Surplus power, stick-to-the-grade ability and flexible hitch assure positive traction on rough grades. Quick get-away from the dump and short turning radius save time on each return trip.

KOEHRING HEAVY DUTY

KOEHRING COMPANY

Pavers · Mixers · Shovels · Cranes · Draglines · Dumptors · Mud-Jacks

3026 WEST CONCORDIA AVENUE, MILWAUKEE, WISCONSIN

· ENGINEERING NEWS-RECORD ·

McGRAW-HILL PUBLISHING COMPANY, INC.

Editorial and Executive Offices: 330 West 42nd Street, New York · Publication Office: 99-129 North Broadway, Albany, N. Y.

F. E. SCHMITT, *Editor* WILLARD CHEVALIER, *Vice-President*

Copyright 1937

VOL. 119 *AUGUST 26, 1937* No. 9

THIS WEEK AND NEXT

PASSAGE BY CONGRESS of a housing bill focuses attention on slum clearance, which is soon to be thrown into municipal laps. What are slums? Memphis sought to find out and developed a numerical method of classifying rundown areas which is described in this issue.

Another municipal problem of growing magnitude involves special water supplies for industrial use. Birmingham is developing such a supply, and its new Inland Dam affords an interesting story on quarrying and placing five classes of fill.

Then there is always the problem of new traffic arteries, and New York is making rapid progress on its Lincoln Tunnel under the Hudson. The story this week is on the lining plant and procedure.

Out in California, work is commencing on the magnificent proposal to re-water the vast Central Valley. Supplementing last week's article on the economics of the project is a more detailed account covering the hydrology of the basin and descriptions of the necessary dams and canals.

Vibrating bridges after erection to locate dangerous structural weaknesses introduces new structural testing and bridge rating possibilities. The equipment developed and the results obtained in 10 years of European testing are described in this issue.

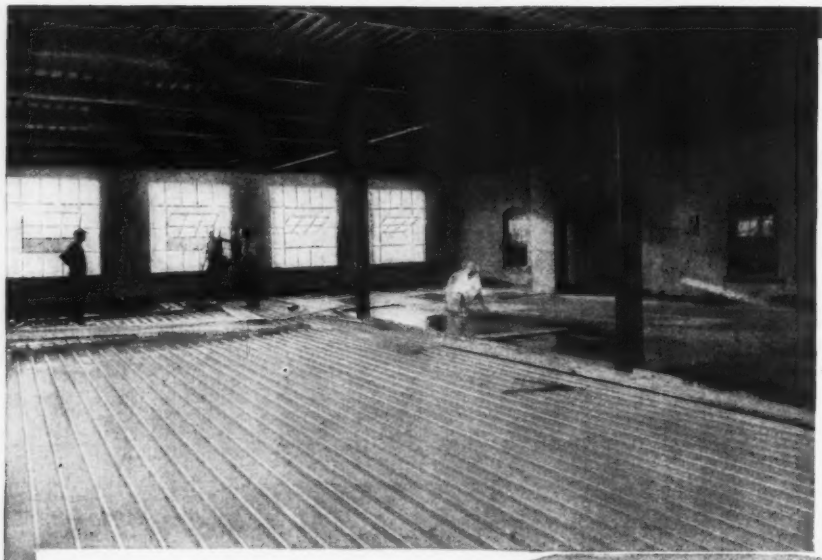
And for readers interested in brief bread-and-butter information there are Field and Office Notes, New Books, Unit Prices and New Equipment and Materials.

NEXT WEEK — Rebuilding the Moffat Railroad over Colorado's Continental Divide.

		PAGE
The Week's Events		329
Reader Comment		336
Editorials		338
Pictures in the News		340
A Yardstick for Slums (*Housing, Sanitary rating, Slum clearance*)	ALFRED H. FLETCHER	341
California's Long-Range Water Plan (*Hydrology, Irrigation, Dams, Canals*)		344
Lining the Lincoln Tunnel (*Vehicle tunnel, Concrete pumping, Forms, Glass tile*)		349
Finding Weak Spots in Bridges (*Induced bridge vibrations, Welding, Field testing*)	RUDOLF K. BERNHARD	353
Five Classes of Fill in Large Dam (*Birmingham water supply, Tunneling, Quarrying, Materials transport, Dam building*)	J. D. JACOBS	357
Wisconsin Sanitation Advances (*Sewage treatment, Stream pollution*)		361
Field and Office Notes		362
New Books		364
The Week's Events (Continued)		366
Unit Prices	*Adv.page*	12
New Aids to the Constructor	*Adv.page*	14
Construction Reports	*Adv.page*	21

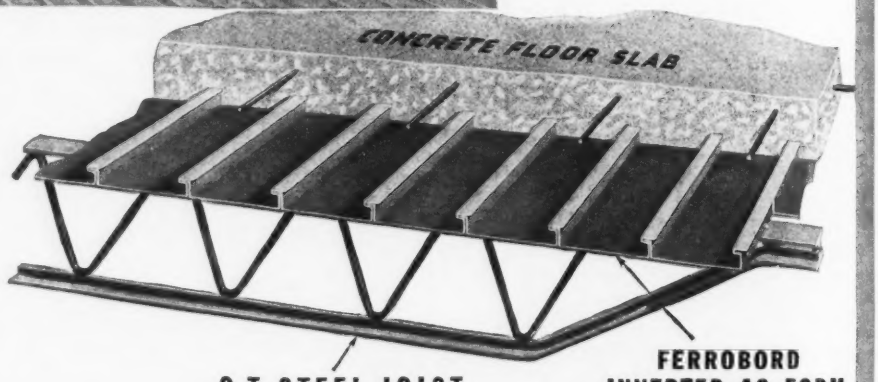
ON THE COVER is a view of a blast in the quarry where fill is being obtained for Inland Dam, a part of the new industrial water supply for Birmingham, Ala. Intake structure, core wall and crushing plant are also shown.

FERROBORD *Advantages*
BRING ECONOMIES IN HEAVY DUTY FLOORS



Truscon FERROBORD installation for concrete floors illustrated at left. All form work for pouring concrete is eliminated. Underside of FERROBORD sheets provides a smooth, attractive ceiling for the floor below. Such ceilings are cleaned quickly, easily and economically. Tests have proved that Truscon FERROBORD sheets used for floor construction as illustrated will carry six inches of wet concrete on a span of 4'-0" without noticeable deflection.

Detail at right illustrates Truscon FERROBORD sheets used for concrete floor construction supported by Truscon Open-Truss Steel Joists. FERROBORD sheets are inverted, interlocked and welded to the joists purlins, or other structural supports. The turned up webs of FERROBORD sheets act as an anchorage for the concrete and prevent distortion or curling during the setting period.



IN BUILDINGS where it is not intended to install ceilings, Truscon FERROBORD sheets (nationally known for their excellence in roof construction) are inverted and used as a concrete form and reinforcement for heavy duty concrete floors and, at the same time, make excellent ceilings for the floors below. Appreciable economies are made possible by this popular application of Truscon FERROBORD sheets. Write for complete detailed information including load tables of the various stock sizes of Truscon FERROBORD sheets and methods of erection.

TRUSCON STEEL COMPANY
YOUNGSTOWN .... OHIO

THE WEEK'S EVENTS

Compromise Made On Housing

Half billion bill raises cost limit in large cities to $5,000 per apartment unit

Late on the final day of the 1937 session, Congress completed action on the long-sought Wagner housing bill by approving a conference report that reconciled differences between the Senate and the House.

As finally approved, the bill creates, within the Department of the Interior, a perpetual corporate body to be known as the United States Housing Authority to be headed by a $10,000 administrator appointed by the President and confirmed by the Senate. The administrator will appoint other employees of the authority, subject to civil service laws up to maximum salary of $1,980, but without such restriction in higher classifications, except that Senate confirmation will be necessary for those receiving more than $7,500. This section of the bill evoked the greatest difference of opinion, the Senate standing for complete civil service classification, and the House for complete exemption.

The authority is authorized to aid in the development of low-rent housing or slum clearance projects by agencies of local governments in three ways:

1. It may loan, for a period of not more than 60 years, up to 90 per cent of the cost of development, which includes planning, financing, land acquisition, demolition, construction (including remodeling, reconstruction and repair) and equipment. The interest charge on such loans shall not be more than ½ per cent above the current federal interest rate at the time of the loan.

2. It may make uniform annual contributions to a project to the extent necessary to assure its low-rent status for a period of not over 60 years but may not contribute more than a percentage of the total cost one per cent greater than the federal interest rate. The local government must also put up 20 per cent of the federal contribution, and the project must include the elimination of an equal amount of unsafe or insanitary dwellings. Local contributions may be tax exemptions.

Contracts of this type must not exceed, in the aggregate, $5,000,000 by July 1, 1938; $12,500,000 by July 1, 1939, and $20,000,000 thereafter without further authorization by Congress.

3. As an alternative to (2), the authority may make capital grants to a project to the extent necessary to assure its low-rent status, but grants may not exceed 25 per cent of the project cost. The local government must contribute 20 per cent in the form of cash, land, or the capitalized value of community services for which a charge is usually made. This method, also, is conditioned upon the destruction of sub-standard housing units equivalent in number to

(*Continued on page 335*)

• • •

Houses Unable to Agree On Pollution Bill

Although both houses of Congress passed stream pollution bills at the recent session, no stream pollution bill received final approval as the conference committee was unable to reconcile the bills of the two chambers. The House is unwilling to accept the more drastic Senate bill and its representatives have been unable to compromise.

This means that the bill will lie in committee during the recess and will be taken up again by the committee when Congress meets next January.

The Senate bill (*ENR*, Aug. 19, 1937, p. 293) would set up a division of water pollution control in the public health service with power to establish regional

(*Continued on page 330*)

MAJOR NEWS

	Page
Housing Compromise	329
New York Tenements	329
Lincoln Tunnel Allotment	330
San Jacinto Strike	332
Pittsburgh Bridge Cracks	332
Montana Power Shortage	333
A.F. of L. Boycott	333
Surveying Teachers	334
Congress Adjourns	335

Tenement Demolition Rises in New York

Number of old law tenements reduced 1,162 in 1936 leaving 60,000 standing

A record reduction in the number of old law tenements was achieved in New York City during 1936, the number of structures being reduced by 1,162, according to a report made by the New York City Tenement House Department. The reduction, which resulted in the elimination of 9,094 dwelling units, is greater than the number for any other year since the enactment of the tenement house law in 1901.

This record reduction, however, leaves 60,000 old law tenements, nearly half of the 136,000 multiple dwellings in New York City, still occupied.

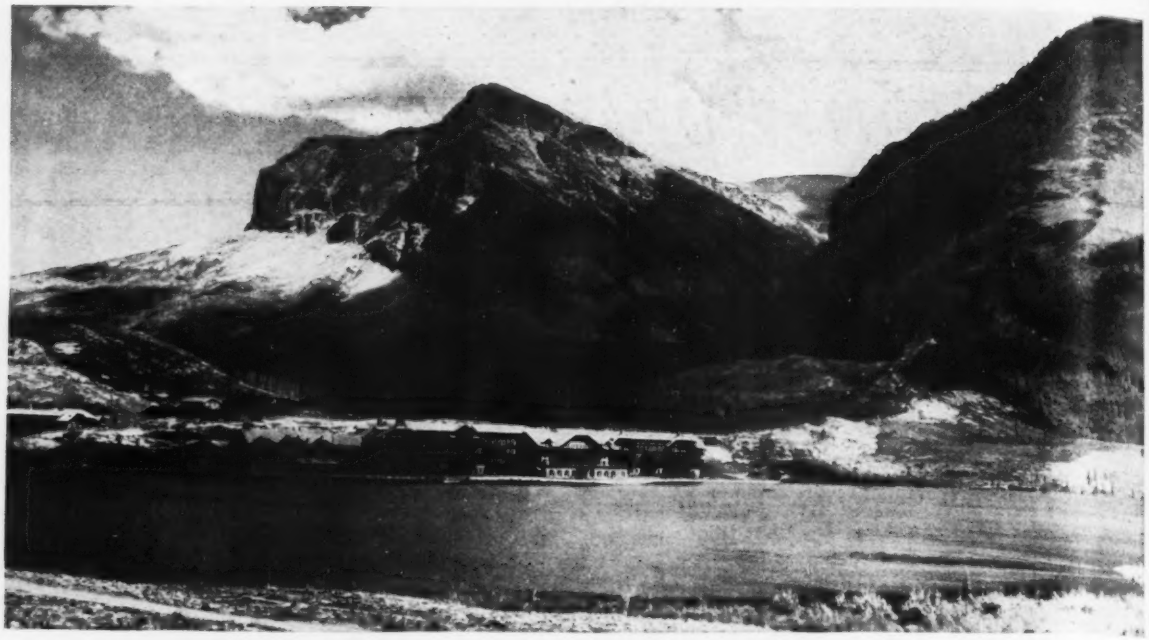
Nine hundred torn down

The 1,162-building reduction was accomplished through the demolition of 902 buildings and the conversion of more than 250 to other uses. During the last three years 2,066 old law buildings containing accommodations for 18,813 families have been removed from the market by demolition. In addition, the number of standing but vacant tenement buildings has been increased to about 3,500, with a total of about 30,000 family units.

A rise from 36,402 at the end of 1935 to 45,249 multiple dwellings which had violation orders pending against them at the end of 1936, indicates a probability that the reduction in numbers of old law buildings in 1937 will be greater than it was in 1936.

Fire retarding in public halls was installed in 1,093 buildings during 1936 in accordance with the requirements of the multiple dwelling law, and cellar ceilings were fire retarded in 5,974 structures. New fire escapes were placed in 6,899 houses.

The report showed that 238 Class A multiple dwellings were erected during 1936 to accommodate 11,254 families. This compared with 153 buildings containing 8,716 apartments in 1935. However, the number of new units provided last year was only about one-third of the apartments demolished, ordered vacated or reported vacant.



THIS IS WHERE THEY'LL TALK ABOUT BLACK TOP ROADS

MANY GLACIERS Hotel at Glacier National Park, Montana, where the third Montana Bituminous Conference will meet Sept. 7-9. The conference is combined this year with the National Road Oil and Asphalt Congress.

The procedure followed at the conference will include the presentation from the floor only of a condensation and summary of the prepared material. This year four papers will be delivered by chairmen of the sections assigned to study particular problems. The four general sections will be: research correlation and development of a bituminous bibliography, under the chairmanship of R. N. Traxler; developments in the fundamentals of bituminous construction, A. H. Benedict, chairman; developments in the practical design and construction of bituminous surfaces, B. E. Gray, chairman; and maintenance of bituminous surfaces, H. H. Houk, chairman. The papers presented by the chairman will combine and condense material submitted by eight or ten committee members. The original papers of the committee members as well as the chairmen's summation will be included in the printed record of the conference.

It is expected that more than 500 highway engineers, contractors and producers will attend the conference. Don A. McKinnon, state highway engineer of Montana, is general chairman.

Port Authority Receives PWA Allotment

Presidential approval has been announced of a PWA allotment of $29,100,000 to the Port of New York Authority for construction of the second tube of the Lincoln tunnel (Midtown Hudson tunnel). Under the terms of the allotment the authority may receive a grant of 115 per cent of the amount that it spends to employ relief labor up to a maximum of $3,100,000. In addition, the authority may borrow from PWA up to $26,000,000 if it finds such a loan to its advantage.

The work on the tunnel for which the loan is made involves the construction of a second tube parallel to the one which is now approaching completion. Each tube will carry two lanes of vehicle traffic under the Hudson River between Manhattan and New Jersey, extending from 39th St. between 9th and 10th Aves. in Manhattan to junctions with New Jersey Routes 1 and 3 in North Bergen, N. J. The first tube was constructed with the aid of a PWA loan of $12,300,000 and grant of $4,780,000.

On the same day on which approval of the PWA allotment was announced, the Port Authority completed the sale of $15,000,000 of 3¼ per cent general and refunding bonds to a banking group at a bid price of 99.5179. This was a lower price than was obtained last December when the authority sold $10,000,000 of 3 per cent bonds at a price of 103.8599.

About $11,306,000 of the proceeds of the bond sale will be used for construction of the Lincoln tunnel. The balance will be used to call outstanding Bayonne bridge bonds in 1938.

. . .

Houses Unable to Agree on Pollution Bill

(*Continued from page 329*)

standards and to institute injunction proceedings against those polluting public waters. Loans and grants would be made to local governments and industries for the construction of treatment plants. The House bill had included the loan and grant provision but gave only advisory powers to the water pollution division.

Confident prediction that stream pollution legislation will be passed early in the next session was made by Senator Lonergan in a farewell address on the floor of the Senate (Aug. 28). Senator Lonergan said he based his prediction on the fact that 80 per cent of those who "constantly pollute our streams are willing to cooperate" in ending this condition. He added that the twenty per cent minority which "does not wish to be bothered" include a small faction which "regards the national streams as open sewers" and is willing to get into politics so as to influence local boards.

The Connecticut Senator concluded with the statement that the pending compromise measure, in the hands of the committee at the ending of the session," is mild indeed when compared with what might become a compelling demand" if legislative steps are not taken shortly.

THE CURRENT TREND

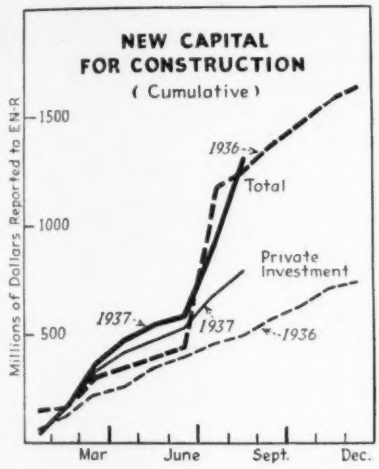
This week's news of contract volume and construction cost factors

New Capital Tops 1936

More Money to Make the Construction Mare Go

New productive capital has climbed above the corresponding value a year ago. Private investment financing in the 8 months ran 55 per cent ahead of last year, but federal financing had slowed down to a dead stop.

This week the first allotments from the 4th PWA program have come through to the tune of $54,864,000, the



first substantial federal financing of non-federal work since March. With this addition, net federal loans and grants are 20 per cent higher than a year ago, still a minor part of the whole.

Federal appropriations for federal work are not yet fully represented in this year's total nor has the allowance been made to cover WPA construction activities for the fiscal year. These additions when available will carry the 1937 curve well above last year's construction financing chart.

State and municipal bond sales of $374,486,000 are 10 per cent higher than a year ago, while corporate security issues for construction, at $393,602,000, are 150 per cent ahead of last year's new financing.

Private Construction Ratio

Private construction has climbed from last year's ratio of 26 per cent up to 48 per cent of this year's heavy construction volume as reported by *Engineering News-Record*. Thus construction contract awards are establishing the trend indicated by the high volume of corporate securities sales reported for new construction.

This increase in private construction volume is divided between industrial building construction and large scale housing developments.

• • •

Construction Materials Employment

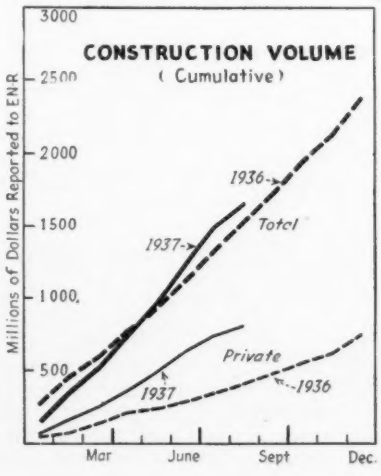
Employment in the production of six major construction materials dropped slightly in July to an index of 63.9 from the June value of 64.3. The July value compares with 57.0 last July as reported by the Projects Division, Public Works Administration.

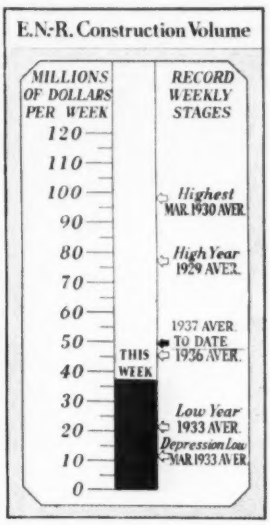
• • •

Lumber Consumption Gains Price Levels to Hold

National lumber stocks at the mills on July 1, 1937 of approximately 7.6 billion feet were 3.3 per cent less than on January 1 and about the same as the volume of July 1, 1936. National lumber consumption is reported at 12.9 billion feet in the first half of 1937. The year's total is expected to be between 26 and 26½ billion feet, a gain of 12 to 15 per cent over 1936 according to the Special Survey Committee on Lumber Consumption.

The Committee reports that the industry has gradually worked its way to a more satisfactory basic condition after the sequence of upheavals during the past nine months in labor, market and shipping conditions. Wholesale prices of lumber having registered during the early years of the recent depression a proportionately greater general decline, have during the past year resumed their former customary relationship to the prices of building materials generally. The Committee expects that in consideration of generally advancing production costs and the recent closer adjustment of production to consumption the present lumber price levels will be generally and substantially maintained.





THIS WEEK'S FIGURES

(Thousands of Dollars)

CONTRACTS

	Week Ending Aug. 27 1936	Aug. 19 1937	Aug. 26 1937
Federal	$12,104	$2,247	$3,510
State & Municipal	23,727	21,432	16,752
Total public...	$35,831	$23,679	$20,262
Total private.	11,879	19,662	17,076
TOTALS	$47,710	$43,341	$37,338

Cumulative
1937 (34 weeks).....$1,675,497
1936 (35 weeks).....$1,540,287

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1936 35 Wks.	1937 34 Wks.
NON-FEDERAL	$563,800	$1,064,926
State & mun. bonds.	340,400	374,486
Corporate securities	157,381	393,602
PWA loans and grants	55,205	66,899
RFC loans	10,814	29,939
Fed. aid for highways	.....	200,000
FEDERAL	$691,237	$261,057
TOTAL CAPITAL	$1,255,037	$1,325,983

ENR INDEX VALUES

Index	Base 1913	1926
Construction Cost (Aug.)..	242.95	116.78
Construction Volume (July)	185	81

San Jacinto Slowed By Strike

Work nearly halted as C.I.O. calls strike on San Jacinto tunnel of Metropolitan Aqueduct

A strike called by the International Union of Mine, Mill and Smelter Workers, C.I.O. affiliate, has nearly halted work on the San Jacinto tunnel of the Colorado River aqueduct. Maintenance men are being allowed to pass through picket lines, and essential maintenance work and pumping is proceeding under direction of the Metropolitan Water District. Drilling and tunnel excavation work is in progress at Lawrence adit and the Cabazon shaft, according to officials of the district.

The strike was called by the C.I.O. group in an effort to obtain union recognition and a preferential shop and to obtain reinstatement of about 80 men claimed by the union to have been discharged because of union activities. No demands involving wages or working conditions have been made, the district states.

In reference to the demand for union recognition and a preferential shop, officials of the district stated: "The district is a governmental body. It would be against the law and against public policy for the district to enter into any agreement that would restrict the right of qualified district citizens to obtain employment on the aqueduct."

On Aug. 18 a striker was shot and a newspaper man and his wife were fired upon by water district police as they left water district headquarters with photographs of strike activities.

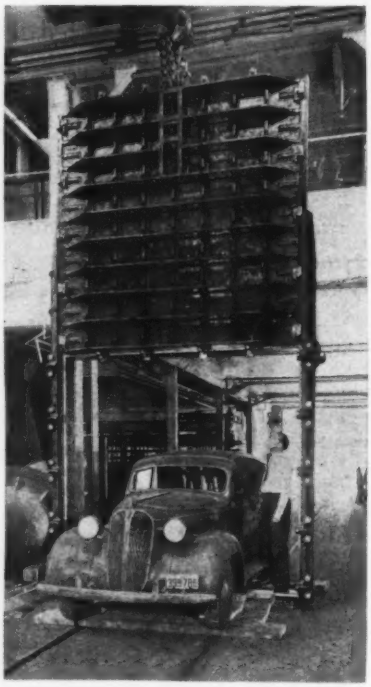
• • •

Local Contribution Waiver Restricted in Flood Bill

The provision in the Ohio Valley flood control bill (*ENR*, Aug. 19, p. 287) which would permit the President in cases of financial stringency to waive one half of the local contribution required under the terms of the Omnibus Flood Control Act of 1935 on projects provided for in that act was modified in the final form of the bill to apply only to projects in the new bill.

As it received final congressional approval Aug. 21, the bill added to the list of authorized flood control projects a number of proposed improvements in the Ohio Valley. The projects were not listed; they are to be selected by the chief of engineers from those listed in his report on the Ohio Valley submitted to Congress last spring.

The bill also carries provisions authorizing the expenditure of $500,000 for channel clearing operations along navigable streams, authorizing a project at Memphis, Tenn., and permitting modifications of approved projects at Johnstown, Pa., and on the Yazoo River.



Crane Co. photo.

CONTROL OF BUFFALO SEWAGE

THIS big sluice gate, 9 ft. square weighing with its frame 14,700 lb. will be installed in the Bird Island sewage treatment plant at Buffalo, N. Y. It is one of thirty motor-driven gates which will be installed in the plant, ranging in their size from 6 ft. square to 9 ft. square.

The $15,000,000 Buffalo sewer project is being carried on by the Buffalo Sewer Authority. Greeley and Hansen are the engineers on the project for the authority.

License Law Is Upheld In Washington Courts

A suit to force the Washington state board of engineer examiners to issue him a professional license, brought by Charles C. Dally, Seattle civil engineer, was dismissed recently by Superior Judge Wright at Olympia.

The suit was brought to test the board's power to refuse licenses to engineers who have practiced in Washington. Mr. Dally stated that he had been a resident of Washington for 32 years and a civil and structural engineer for 14 years.

Cracks Discovered In Bridge Slab

Westinghouse Bridge deck at Pittsburgh requires repair because of faulty expansion joints

As a result of not carrying the reinforcing steel in the deck slab of the George Westinghouse concrete arch bridge at Pittsburgh near enough to the face of the expansion joints, cracks have developed whose repair will cause some inconvenience to motorists using this Lincoln Highway structure, according to an announcement by E. E. Brandow, bridge engineer of the Pennsylvania state highway department. The announcement, picked up and sensationalized by Pittsburgh newspapers, aroused interest in engineering circles, particularly since accompanying illustrations showed definite cracks near the top of the spandrel columns. These cracks are in reality the construction and expansion joints in the jack arches under the curb, purposely built into the structure.

Cause of break

George S. Richardson, who was assistant engineer of bridge design of Allegheny County when the bridge was built, answered a query of *ENR* as follows:

"A defect of a very minor nature has developed in the roadway slab at two of the expansion joints and possibly at a third one. At these points the roadway slab has cracked a few inches from the joint, primarily because the reinforcing bars in the bottom of the slab were not placed with hooked ends near enough to the joint, with the result that the slab has cracked beyond the end of the rods. The state highway department, now responsible for the maintenance of the bridge, discovered these defects several months ago because they noticed that the brick paving near two of the joints was not standing up. They did not consider it serious enough to justify immediate repairs and now are just getting around to the point of taking care of the trouble."

An article by Mr. Richardson, (*ENR* April 22, 1931, p. 681) described the design of the bridge, which contains the longest concrete arch in the United States, 460 ft. center to center of supports. The construction was covered in an article published in *ENR* July 21, 1932, p. 67.

It is reported that repairs to the bridge deck will consist of placing structural steel shelf angles under the ends of the slabs at the expansion joints. Half of the roadway will be closed at a time while repair work is in progress.

Power Shortage In Montana

Mining interests protest Fort Peck Dam demand as low stream flow affects hydro plants

Chief of Engineers Gen. Edward H. Markham has received urgent appeals from western mining interests to curtail the construction activities at Fort Peck Dam to relieve a serious power shortage in Montana. The state is suffering a severe shortage in electric power because of abnormally low stream flow, reported by power company officials as the lowest on record, which is curtailing the output of the several hydroelectric plants which serve the dam as well as the mines and mills. Lack of power has already resulted in curtailment of operations in the Great Falls area, with repercussions as far away as Nevada and Utah, for mines in these latter states ship zinc concentrates to the Anaconda Copper Co. smelters for electrolytic reduction. The mining men contend that unless the situation is relieved a further reduction in activities will be neecssary, which would throw many men out of work.

Gen. Markham has replied that it is impossible to slow down the Fort Peck work since the dam is now at a critical stage because of recent river diversion and the closure fill section must be carried up high enough this year to withstand high water attacks next spring. Furthermore, he states, curtailment of work at Fort Peck would throw many more men out of work than would curtailment of mining activities.

The hydro plants of the Montana Power Co. supply 90 per cent of the power used in the state, including the Fort Peck consumption. The company has an installed capacity of 294,000 kw., but can now produce only 200,000 kw. The company is importing 40,000 kw. from the Washington Power & Light Co., about the limit of capacity of the interconnecting distribution lines. At present the demand is 70,000 kw. more than the available supply.

Fort Peck Dam is using 40,000 kw., mostly for dredging operations, under a governmental contract. A 287-mile transmission line was built from the Great Falls plants to the dam at the beginning of the project. Dredging operations at the dam will shut down with the first cold weather, usually early in November, which will greatly relieve the present shortage of power. Spring runoff will take care of all power requirements early next year, and by next June the Montana Power Co. Flathead plant, of 56,000 kw. capacity, will go into operation. Therefore the critical period will last only two months more.

Officials of the Federal Power Commission, who have been investigating the Montana situation, report that there is no surplus power at present throughout the entire Northwest. They are studying the advisability of early installation of a plant at Fort Peck, for which provision was made by fitting up one of the four diversion tunnels as a penstock. Previous plans did not contemplate the plant installation for some time to come.

• • •

Vacuum Dust Control Tests Successful in Wet Rock

The vacuum type of rock drill dust control apparatus will operate satisfactorily under wet rock drilling conditions, according to the results of tests conducted last week in New York under the direction of Theodore Hatch, engineer of industrial hygiene for the state department of labor. Furthermore, the tests indicate that a drilling speed is possible in hard rock with dry drills using the control apparatus equal to that obtained by drilling with standard wet drills.

The three commercial makes of control apparatus—that of the Kadco Corp., Markley Dust Control and Spencer Turbine Co.—were tested in drilling an outcrop of exceptionally hard granite. Three test runs were made on two standard types of drills, a wagon drill and a drifter, the latter mounted on a quarry bar. The first run in each case was with the drills as wet machines; the second was run with the drills dry and the dust control apparatus in action; the third run was in two parts, first with the drills running dry but with a heavy flow of water introduced into the hole from the outside, the second with the drills running wet, both using the dust control equipment.

In all cases where the dust control apparatus was used in connection with wet holes the water was trapped in the primary collector, and the secondary collectors, where the fine dust is screened out, were perfectly dry. A relief valve in each primary collector passed the surplus flow of water as the tanks filled up.

Mr. Hatch stated the tests were made to answer inquiries of contractors and other users of rock drills concerning the effectiveness of the vacuum control devices in wet rock. New York state now has a silicosis prevention law that requires the use of some approved form of dust control apparatus in all rock drilling. The three vacuum systems have been approved.

A. F. of L. Boycotts C. I. O. Goods

Carpenters boycott C.I.O. lumber as C.I.O. electrical workers threaten court action

The United Brotherhood of Carpenters and Joiners of America, A.F. of L. affiliate, on Aug. 16 ordered members of all its local unions in the United States and Canada to refuse to work with materials furnished by unions affiliated with the C.I.O. Officials of the Brotherhood asserted that C.I.O. organizers had been active among mill and factory workers in the Northwest timberlands and asserted that local unions of carpenters were being urged to affiliate with the C.I.O.

Timber workers locals in the Northwest, which were accepted into the A.F. of L. as federal locals some years ago, have recently been seceding to the C.I.O., claiming unsatisfactory treatment by the A.F. of L.

Meanwhile, Clinton F. Golden, regional director of the Steel Workers' Organizing Committee of the C.I.O., announced Aug. 22 that court action would be taken against A.F. of L. boycott activities, particularly in the electrical field. He said that action would be taken charging violation of the Wagner Act in cases where boycotting prevented operation of collective bargaining agreements.

Mr. Golden said that boycotting action by A.F. of L. electricians against goods produced by the United Electrical Workers Union, C.I.O. affiliate, had caused the closing down of the Enameled Metals Co. of Etna, Pa.

• • •

Hackett Resigns from PWA

Col. Horatio B. Hackett has resigned as assistant administrator of the Federal Emergency Administration of Public Works, effective Sept. 1, to return to private business. Explaining his resignation, Col. Hackett said:

"The PWA has cleared its most difficult hurdles and the new program has already been initiated . . . I believe that I can offer my resignation at this time without serious inconvenience to the organization."

Col. Hackett became associated with PWA in 1934 when he was appointed general manager of the Emergency Housing Corp., a PWA subsidiary. On June 15 of that same year he was appointed director of housing when the housing division absorbed the functions of the Emergency Housing Corp. He became assistant administrator of PWA in May, 1935.

Surveying Teachers Set Courses

Special Correspondence

Preparation and approval of minimum essential contents for courses in surveying were made at the First Surveying Teachers' Conference, held under the auspices of the Society for the Promotion of Engineering Education, from July 25 to Aug. 5 at Iowa State College's Camp Marston, located on Rainy Lake, 35 miles east of International Falls, Minn.

The conference was attended by 31 teachers of surveying, representing 26 institutions throughout the country. Invited guests, present for several days each, as speakers on special subjects directly related to surveying teaching were: H. M. Dibert, W. & L. E. Gurley, Troy, N. Y.; M. S. Jordan, Chicago representative, Buff & Buff Co.; and M. Y. Poling, consultant, Governmental Projects Section, WPA, Washington.

The surveying teachers conference, arranged by an S.P.E.E. committee appointed for the purpose at the 1936 meeting at Madison, Wisc., had for its principal objective the preparation of minimum standards for college surveying courses. This objective it accomplished, and in addition it aided in developing a solidarity of interest in surveying problems that previously has been lacking. The conference also considered such subjects as summer camps and licensing of engineers, recommending with respect to the latter that practical work in various fields of land surveying be placed on the same basis as engineering work and considered "responsible charge of work"; that responsible charge of engineering teaching, including surveying teaching, at approved institutions be also considered as "responsible charge of work" and that the theoretical portions of examinations for state license be offered applicants immediately on graduation.

Minimum course essentials as set forth by the conference included the following subjects: elementary surveying for non-civils; elementary surveying for civils; advanced surveying; a short course in photogrammetry; route surveying, curves and earth work.

The two elementary course essentials include surveying orientation lectures, distance measurements, leveling, and field exercises in use of the transit. In addition, the course for civil engineering students would include the location of details, traverse computations, plotting, methods of land description, and adjustment of instruments.

The committee on content of course in advanced surveying recommended that the following points be covered in this course: precise measurements of angle, elevation and distance; and the test of adjustment of all equipment used; adjustments of the observations; an appreciation of the errors involved and their relation to the economy of the operation; hour-angle azimuth determination by observation on Polaris; principles of topographic surveying and mapping sufficient to enable the student to make a complete map of any area which is not large enough to involve geodesy; general principles necessary for the survey of engineering construction works.

Material to be covered in a short course in photogrammetry, as reported by the committee on aerial photographic mapping instruction, suggests the following headings: terrestrial photographic surveying and mapping; stereoscopic principles; principles of aerial photographic surveying and mapping; graphical methods of map construction; oblique aerial surveying; stereoscopic mapping. In addition, the committee recommended a brief summary of the subject for inclusion in other courses in surveying.

A course in railroad and highway route surveying, called "Curves and Earthwork," was outlined to include simple curves, compound and reverse curves, transition curves, vertical curves and various earthwork computations. It is the opinion of the committee that the fundamentals of curves and earthwork apply equally to all phases of route surveying including railroad surveying, highway surveying, canals, and transmission lines.

THEY RAN THE SURVEYING CONFERENCE

SPECIAL COMMITTEE which was in charge of the S.P.E.E. conference on the teaching of surveying. Left to right, they are: Brother A. Leo, Manhattan College; Paul P. Rice, Lafayette College; John S. Dodds, chairman, Iowa State College and F. W. Welsh, State College of Washington.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

STATES that have lifted tolls from bridges on federal-aid highway systems are entitled to a refund of one-half the original cost of the bridges under the terms of a bill signed by the President Aug. 17.

An act directing the Corps of Engineers to investigate the feasibility of the Cabinet Gorge reclamation and power project on the Clark fork of the Columbia River in Idaho was signed by the President Aug. 17.

The Geological Survey has received a PWA allotment of $300,000 for continuation of topographic survey work in 13 states. Of the amount allotted, $152,000 will be used for publication costs.

Secretary of the Interior Ickes has been appointed administrator of the Porto Rico Reconstruction Administration, which has been reorganized as a unit of the Department of the Interior under the general supervision of a cabinet officer. Secretary Ickes has appointed Miles H. Fairbanks, regional administrator of the Porto Rico Reconstruction Administration, as acting assistant administrator, with headquarters at San Juan. At the same time, E. E. Glover was appointed director of the Washington office of the Administration.

Congress Leaves Much Work

Important bills remain to be acted on as Congress adjourns

When the second session of the 75th Congress convenes next January it will resume consideration of a number of important measures left unfinished during the rush for adjournment on Aug. 21, including bills dealing with wage and hour standards, government reorganization, stream pollution control, regional water planning authorities, and many other matters of lesser importance. A general summary of the work accomplished this year appeared in *Engineering News-Record*, August 5, p. 208; changes in the status of bills during the last few days of the session are as follows:

Bills of general interest

Passed:

Reorganization of the lower federal courts, providing for direct appeal of constitutional cases; optional intervention by the Attorney-General in constitutional cases between private litigants; and tightening up of injunction proceedings affecting federal law enforcement.

Permitting local taxing agencies (municipalities, irrigation districts, etc.) to seek financial reorganization under the bankruptcy laws.

Directing the Department of Labor, with other federal agencies co-operating, to take an unemployment census by voluntary registration.

Wagner housing bill, setting up a United States Housing Authority and providing for loans and grants to assist local housing agencies.

Action incomplete:

Stream pollution bill, setting up in the Public Health Service a Division of Water Pollution Control. Passed both houses in different forms; conference committee unable to agree.

Reorganization of the federal executive departments. House passed two bills, with two more in preparation; Senate committee considering a revised omnibus bill.

Navigation and flood control

Passed:

Rivers and Harbors Bill of 1937, authorizing 146 navigation improvement projects totalling $53,701,525.

Flood control authorization bill, amending the Omnibus Flood Control Act of 1936 by adding a number of projects in the Ohio Valley and a $9,000,000 project at Memphis, Tenn.; authorizing revision of flood control plans on the Yazoo River and at Johnstown, Pa.; authorizing the President to modify requirements for local contributions in cases of financial inability to comply.

Setting up a marketing authority for surplus power from the Bonneville project on the Columbia River.

Permitting states to collect federal-aid road funds for 50 per cent of the cost of toll bridges freed.

Granting federal approval to an interstate compact creating a Potomac Valley Conservancy District (Maryland, Virginia, West Virginia, District of Columbia.

Vetoed:

Directing the Corps of Engineers to make a comprehensive study of major rivers and prepare a plan for flood control and water conservation.

Action incomplete:

Permitting the Secretary of War to increase the storage capacity of flood control dams for water supply and other purposes provided the additional cost is defrayed by local governments. Passed Senate; no action in House.

Public Buildings

Passed:

Army housing authorization bill approving $25,587,000 in construction projects at various army posts.

Action incomplete:

Navy housing authorization bill approving navy construction projects totalling $6,099,057. Passed Senate.

Reclamation

Passed:

Authorizing $500,000 for small storage reservoirs in reclamation states.

Setting up three-man commission to study reclamation finances and economics, with particular reference to the need for deferring payments to the federal government.

Authorizing the Secretary of Agriculture to aid in the development of water storage facilities in arid and semi-arid sections.

• • •

McNinch Becomes Member Of F. C. C.

President Roosevelt on Aug. 17 nominated Frank R. McNinch, chairman of the Federal Power Commission, to be a member of the Federal Communications Commission for the unexpired term of the late Anning S. Prall. Mr. McNinch will not relinquish his position with the power commission but will take a three months absence.

The President also appointed Commander T. A. N. Craven, chief engineer of the communications commission, to fill the other vacant membership due to Mr. Stewart's retirement.

Compromise Made On Housing

(*Continued from page 329*)

the new accommodations. In addition the President may, at his discretion, grant to the project an additional 15 per cent of its cost, from relief funds, to be used in paying labor costs. Aggregate totals of capital grants are limited to $10,000,000 per year.

To qualify for any of these subsidies a project must come within a general cost limitation of $4,000 per family dwelling unit or $1,000 per room (excluding land, demolition and non-dwelling facility costs). This may be increased by the authority to $5,000 and $1,250, respectively, in cities of over 500,000 population to compensate for higher construction costs. Future projects are to be constructed in an economical manner, avoiding elaborate or expensive design or materials, with an average construction cost not greater than the cost of dwellings in the same locality constructed by private enterprise under existing building regulations and similiar labor standards. Tenants must be selected from families with incomes not exceeding five times the rental charged (including the cost to them of heat, light, water and fuel), a proportion that is increased to six for families with three children.

To finance its activities the authority has: Capital stock of $1,000,000 to be purchased by the Treasury (an item appropriating this amount was added to the third deficiency bill, passed the same day). An authorized appropriation of $25,000,000 for the current fiscal year (presumably to be carried in a later deficiency bill). Authority to issue tax-exempt bonds, with principal and interest guaranteed by the federal government, to aggregate $500,000,000, of which $100,000,000 may be issued immediately, an additional $200,000,000 after July 1, 1938, and an additional $200,000,000 after July 1, 1939.

Not over 10 per cent of the authority's funds may be expended in any one state.

Low-cost housing projects already completed or under construction by other agencies of the federal government are turned over to the Authority, which is directed to complete and transfer them to local housing authorities as soon as practicable. As soon as the transfer takes place the projects become eligible for subsidies under the provisions of the law. Disposal may be by sale or by lease.

News continued on page 366

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Unionization of Engineers

Sir: With reference to the letter of H. A. Steingart in the August 5 issue of *Engineering News-Record* on the subject of engineers' unions, I, too, am an engineer and am not a union man, and I cannot too strongly commend the statements attributed to you which Mr. Steingart condemns.

If a man who has prepared himself for a profession must depend on outsiders to exploit his talents, if he must thus admit that he cannot sell his services for a proper reward, but must be thrown into the melting pot, if his training has not raised him to a level higher than the laborer or mechanic who may require organized effort to keep him in his place, then that man has missed his calling and probably belongs in the assembly line.

Can you imagine a professional man publicly announcing himself as "John Jones, Attorney-at-Law, Member Local 107 C.I.O." or another as "James Doe, M.D., Affiliated with A.F. of L."? Does the professional engineer aspire to such heights that he should be proud to attach such an identification to his standing alongside of Member A.S.C.E. or a kindred society?

Your characterization of unions as "exploitation by professional labor boss and mobster"—to quote Mr. Steingart—hits the nail on the head; give us more of this same stuff; tell it to young and old till the message is absorbed by those intelligent enough to think for themselves and to act on their own convictions. Thus the profession will be purged and refined and maintain its high professional standard.

More power to your pen.

Philadelphia, Pa. S. W. BARAKAT
August 12, 1937

Unionization Necessary

Sir: Recent letters discussing the labor situation and unionization of engineers have been vitally interesting, but most of them have been from large employers. The employee's reaction also deserves consideration.

As a civil engineering graduate employed in a subprofessional capacity, I have discussed the wage and unionization problems with both college and non-college subprofessional men in construction and allied engineering organizations. While most of these men want to avoid unionization, because of the deprivation of individuality, abhorrence of recent union activities, and professional pride, it is universally conceded that the white-collar and subprofessional groups are underpaid in most lines of business and industry.

The pay received is incommensurate with the requirements of the positions as to education or training, experience, and mental ability. This is especially so when compared with the wages of the skilled trades and of equipment operators. This is a problem that must be met, sooner or later, either voluntarily or through the force of unions. It is undoubtedly to the advantage of the employers to avoid such unionization, because of the jurisdictional and hourly restrictions of union labor. It behooves the employers therefore to increase the wages of technical men of their own free will.

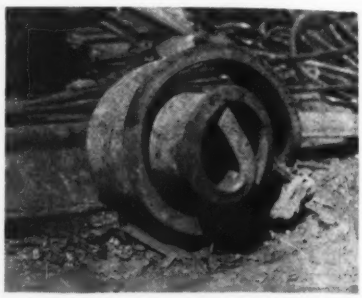
Office overhead is such a small portion of construction cost, as compared to the cost of labor and compensation insurance, that it would seem wise for the employers to buy this form of insurance against unreasonable employment costs. Unions seem to be oblivious of the fact that they are forcing construction costs above the point of diminishing returns to the industry and, just as definitely, to the workmen themselves. Let not the profession lose sight of this fact also.

Chesapeake City, Maryland RICHARD S. WILKINS
Surveyor, U.S.E.D.
July 21, 1937

Sheetpile Meets Boulder

Sir: Readers of *Engineering News-Record* may be interested in the accompanying picture showing the remarkable distortion of a steel sheetpile. The pile in question was 13¼ in. wide and ⅜-in. thick in the web, and weighed 38 lb. per lin. ft. It was driven in 1926 to protect the crib work at the east pier at the northern entrance to Keweenaw Waterway, which is located in Michigan.

The particular pile shown was 26 ft. long. It was driven with a steam hammer through 12 ft. of water and penetrated 14 ft. into a very compact mixture of clay and fine sand containing numerous boulders. It was properly interlocked with adjoining piles on both sides. In May, 1937, when this sheet pile wall was removed, great difficulty was experienced in pulling the piles because many of them were very badly distorted, apparently because they encountered boulders when being driven. The one in question struck a boulder about 17 ft. below the water surface. The web was very neatly sheared from the female interlock for a length of 9 ft. and the web and male interlock curled up into a tight spiral.



What happened to a steel sheetpile that hit a boulder. Nine ft. curled into this tight spiral.

Duluth, Minn. A. B. JONES
June 30, 1937 Major, Corps of Engineers, District Engineer

Beam Deflections

Sir: In Prof. Witmer's discussion of beam deflections by moment-area (ENR, May 6, 1937, p. 677) there appears an Eq. (2) which one can easily misinterpret, especially if a person is in a hurry to get results.

By using the method of elastic weights (or what is sometimes called the conjugate beam method) it is a very simple matter to develop an equation for the deflection at any

point between the left support and the concentrated load.

Using the loading and notation as given by Prof. Witmer and calling the span length L and representing the distance from the left reaction to the concentrated load by b, then the deflection at any point x between the left support and the concentrated load is:

$$\Delta_x \text{ (when } x \text{ is less than } b) = \frac{Pax\ (L^2 - a^2 - x^2)}{6EIL} \qquad (A)$$

When b is greater than $L/2$ the point of maximum deflection is at a point x distant from the left support, and by the method of elastic weights,

$$x = \sqrt{\frac{b\ (b + 2a)}{3}} \qquad (B)$$

To the writer, Eq. (A) seems more easily understood and will solve the deflections more readily than Eq. (2). Substituting the value of x from Eq. (B) in Eq. (A) the maximum deflection can readily be solved, whereas by using Eq. (2) several trials would have to be made to ascertain the maximum deflection.

Washington, D. C. A. W. FISCHER
May 22, 1937 Veterans Administration

Evaporation Does Conserve

Sir: May I take exception to the statement made by W. B. Langbein (*ENR*, Aug. 5, p. 212) that evaporation does not assure true conservation.

It is conceded that the large air movements "are generally continental in extent and beyond the influence of man." However, merely because evaporated moisture practically never falls on the land and water of its origin is no proof that evaporation does not conserve. In the region of local thunderstorms, rainfall is inevitably increased, even though but slightly, by added local sources of moisture. Cloud levels are lowered, evaporation from falling rain drops is reduced, and convection is aided by increased evaporation from conserved runoff.

Evaporation in sections of the Great Plains area and precipitation somewhat eastwardly can be increased by conserving the runoff water and forcing it through one or two more hydrologic cycles in addition to the five, ten, or fifteen cycles it already performs in that region. As Prof. Brooks aptly remarked respecting Nebraska in the *Bulletin*, American Meteorological Society, May, 1935, p. 145, "There are thunderstorms anyway; give them more vapor and they'll rain."

The only truly successful rainmaker is rain itself. Wet and dry spells are, to a degree, self-perpetuating. The air is no storehouse for moisture. A few days' evaporation after a heavy rain sends about as much moisture into the air as it can hold in the face of the normally prevailing air currents. When the next low area passes over, some of this moisture is inevitably reprecipitated, thus furnishing renewed evaporation opportunity and further moisture for "Nature's rain factory."

Conserving runoff to increase evaporation and seepage cannot prevent great droughts. Nevertheless, man has some power to change the total continental rainfall even if he cannot change the total continental runoff. So long as the ocean level remains substantially constant, the total runoff from the land area of the earth must also remain constant; otherwise moisture must be continuously escaping into space at an appreciable rate, or the aggregate solar radiation must change sufficiently at the same time to change the excess ocean evaporation equally.

Removal of forest growth and drainage of ponds and marshes has eliminated from the hydrologic cycle one of nature's rainfall-stabilizing influences. In place of the slow and steady outpouring of moisture by vegetation that drew its supply with comparative regularity from a soil reservoir of great depth, month after month, through a long growing season, we have substituted the intermittent transpiration of shallow-rooted grains, dependent mainly upon current rainstorms and maturing before midsummer. In place of the practically continuous transpiration from prairie sod, we have substituted the intermittent transpiration of sparse grain growth during a short season and barren, dust-mulched prairie soil during the remainder. "The records show the actual course of events," as Mr. Langbein states. Only the events are susceptible of various interpretations.

Minneapolis, Aug. 3, 1937 ADOLPH F. MEYER, Hydraulic Engineer

For Better Building

Sir: The article of E. E. Seelye (*ENR* July 15, 1937 p. 93), and the subsequent letters of Aubrey Weymouth and H. G. Balcom, express sound opinions and suggestions regarding the structural safety of building construction. It is universally agreed that the supervision of construction should be by qualified professional builders. But proper supervision cannot be bought or sold for wages that are lower than those which are paid to the common laborers.

Although incompetence, like crime, cannot be legislated out of existence, the causes of uneconomic and disorderly construction can be eliminated, and most of the disorders prevented before they take physical form. Our means to this end is to use a certified analysis of the quantity, quality and value as a requisite for buying and selling all building construction.

New York, N. Y. G. SZMAK
Aug. 2, 1937. Construction Survey Co.

Raveling Slab Edges

Sir: Many of our contracts include concrete floors on earthfill wherein the slab is poured in checkerboard fashion, with cold joints, and with electrically welded mesh coat for each checkerboard section so that, in case of settlement, the section of floor will settle as a unit. These floors are frequently subject to hard wear from steel-wheeled trucks with the result that we experience some raveling at the cold joint.

We are looking for an inexpensive armor strip or some construction which will reduce the amount of raveling.

Los Angeles, California A. R. MACPHERSON
Ford T. Twaits Co.
Construction Engineers

Names Incorrectly Spelled

Sir: I notice that the names of two of the students listed in my article "Bridge Design Data Chart" (*ENR*, July 22, p. 158) are incorrectly spelled. The first name should be Augustin Llano, and the third should be Jesus Malo.

Philadelphia, Pennsylvania July 28, 1937 WALLACE E. BELCHER

ENGINEERING NEWS-RECORD

Copyright 1937, by McGraw-Hill Publishing Company, Inc.

Volume 119, Number 9

Editor, F. E. SCHMITT · *Editorial Staff*, V. T. BOUGHTON
N. A. BOWERS, W. G. BOWMAN, W. W. DE BERARD
C. S. HILL, H. W. RICHARDSON, E. J. CLEARY

Editorial Offices at 330 West 42nd Street, New York

AUGUST 26, 1937

BEFORE DIRT CAN FLY it is necessary to gather data and make plans, sometimes during many years, as the record of the Central Valley project emphasizes. This undertaking, like every other major construction job, is not a quickly conceived inspiration but is the outgrowth of investigations and studies continued over many years. The original conception that the streams of northern California might be used to water parched lands hundreds of miles to the south was useless until sufficient water data could be collected to show that the scheme was feasible. Plans had then to be developed and studied for practicability, cost and benefits, which required more years. Finally many difficult financial and legal problems had to be worked out. Had the facts about available water and its possible uses been in existence at the start, actual work could have begun much earlier and the emergency of the southern valley lands would now be well on the way to being relieved. Thus the project shows how important water study is to construction as well as to virtually every other interest. Once the construction industry appreciates this importance it may see reason for active support of efforts to bring about more thorough water study.

Railroad Research

CONSOLIDATION OF RAILROAD RESEARCH in a new division of joint engineering research of the Association of American Railroads, as announced recently, should do much toward speeding the time when research now in progress will begin to show more beneficial effects on railroad income. The new division will not attempt to take over or to duplicate the research of individual roads, but it will endeavor to coordinate that work more closely than has been possible in the past. The American Railway Engineering Association has done much along this line, but its scope has been limited by the fact that the A.R.E.A. work, after all, is secondary to the regular work of its committee members. The staff of the new division, on the other hand, will have correlation of research as its main objective. Under centralized supervision, and supplemented by new research that may seem desirable, current studies such as those of track stresses and of rail failures should show new records of accomplishment in practical application.

Dynamic Action

UNTIL QUITE RECENT TIMES the strength of structures was commonly looked upon as a question of static resistance only. Some fifteen or twenty years ago, however, practical engineers as well as research men began to realize that the dynamic action of loads is not truly represented by static stress calculations. As a matter of fact, even before empirical impact formulas came into use bridge engineers recognized the dynamic effects of railway trains; many early specifications allowed only half as great a unit stress for live load as for dead load. Later the fundamental field measurement of impact stress by Prof. F. E. Turneaure gave a more correct picture of dynamic effects and cleared the way for subsequent studies, such as the extensive researches of J. B. Hunley. Later still, impact effects of building loads were found to be significant. As a logical evolution from this antecedent work, artificial oscillation has now proved to be of practical value in measuring dynamic effects. The bridge-testing developments outlined by R. K. Bernhard in this issue, the dynamic study of California buildings under horizontal oscillation by the Coast and Geodetic Survey and recent studies of oscillation of water-tank towers indicate the important position now given to dynamic considerations.

Ace Troublemaker

NO SINGLE feature in engineering structures gives so much trouble as temperature expansion and contraction. In spite of continuous efforts toward improved design of expansion joints, the difficulties persist. Perhaps if the damage done by poor expansion joints were more serious from a safety standpoint, more progress would be made. But generally only local damage results. However, such shortcomings are costly to correct and often cause serious embarrassment, as for example in the current case of the Westinghouse concrete arch at Pittsburgh, where an announcement by the state highway department that cracks in the roadway would have to be repaired was followed by newspaper stories of dire portent accompanied by alarming pictures of cracks in the jack arches of the roadway. Actually the "cracks" shown were construction and expansion joints intentionally built into the structure. The cracks that represented the real damage were in the pavement slab near two expansion joints and resulted from stopping off the bottom reinforcing bars too soon. Whether a fault of design or of construction, the cracks are not of great moment in themselves, but

they have been made a source of general embarrassment. Some research funds might well be devoted to giving that ace troublemaker, the expansion joint, its day in the testing laboratory.

The Colorado Tamed

SINCE COMPLETION OF BOULDER DAM the nature of river construction operations on lower reaches of the Colorado River has changed. Proof of this is the impunity with which diversion of the river's flow was carried out at Parker Dam, and again, in the early part of August, at Imperial Dam. In both cases the diversion and the provision for maximum flood flows were vastly different from that necessary without the protection of Boulder Dam. It is true that there are inflowing streams in the lower reaches, but with flow in the main stream controlled the combination of peak floods is eliminated and work in the river is therefore less hazardous. In like manner Grand Coulee Dam on the Columbia and the projected Sacramento and San Joaquin storage dams of the Central Valley development in California will have high flood-control value. With their completion, an excellent start will have been made toward bringing under control the flood hazards of all major streams of the Pacific Coast.

Inspection Invited

STREAM-POLLUTION LEGISLATION, which narrowly missed passage in the last two sessions of the Congress, has now reached the point where careful public inspection can be made. From the rough working drafts of many plans submitted there has finally evolved a workable bill (*ENR* Aug. 19, p. 293). Many details, however, merit consideration before the bill is enacted.

The amended bill would set up a federal division of water pollution control in the Public Health Service, with power to fix standards of purity for navigable waters and their tributaries. Grant of the right to sue offenders would go far toward making these standards mandatory. Another provision authorizes the Treasury to make grants in aid or loans to communities or to industries for pollution abatement projects, a provision that would largely establish federal control of sewage treatment throughout the United States.

Undoubtedly the proposed grant or loan system would give a strong impetus to sewage and industrial waste treatment. One of its possible results, however, is the virtual paralysis of state authority over sanitation, and it will be conceded that this would be a great loss to sound public administration in view of the enviable record of efficiency that state sanitary activity has made.

Increase in stream pollution has made the pressure for abatement exceedingly strong. Action by the states, though guided by best intentions, has not been forceful enough to keep pace with the growth of the evil. Under these circumstances it is hardly open to question that federal legislation to abate stream pollution will be passed at an early session. It will be most beneficial if it preserves uninjured all present agencies and forces concerned with stream pollution, and if it includes clear legislative definition of standards and limits of federal action. Full discussion of the bill leading to the drafting of any needed modifications will help to assure this objective.

The Housing Bill

IF THE PRESIDENT SIGNS the slum clearance housing bill that Congress left on his doorstep when it adjourned, there is a chance that house construction next year will be mildly stimulated. By the requirements of the bill, slum clearance will proceed at exactly the same rate as the new housing. Beyond this forecast it is difficult to go, because the interest of the local communities in slum clearance housing has never been demonstrated.

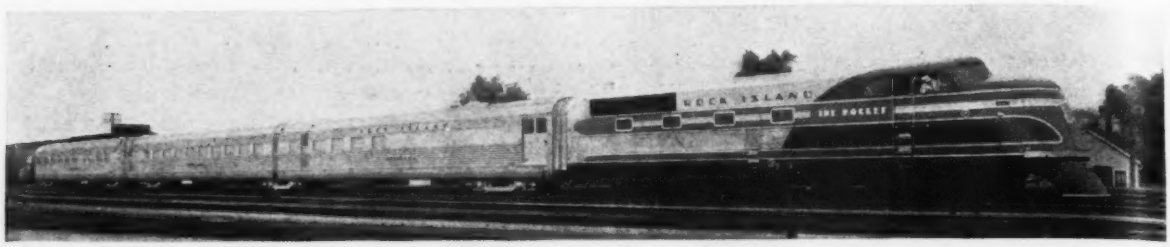
Every city contains sincere groups who have talked a good game of housing, to use a sports metaphor, but now comes the real test: raising 10 to 20 per cent of the cost of the projects from local funds. Although the provision for local responsibility may cause difficulties and may perhaps delay the start of actual construction, it is fundamentally sound doctrine for any public housing program, as the PWA Housing Division and Secretary Ickes have always maintained.

In most of its other provisions, too, the new bill solicits respect. The initial fund provided is properly modest in amount. The interest rate of ½ per cent over the going federal rate is fair, and represents good business. The $4,000 and $5,000 limit on construction cost is salutary because there has been a tendency on some of the recent projects to forget the low-cost objective.

Finally, the limit on tenants' incomes to 5 or 6 times the rental is proper to safeguard the housing for those who need it. By providing for a rental subsidy, the bill attempts to keep these rentals at the absolute minimum, but even so some of the people who will be turned out of the slums which are razed may not be able to afford the new housing—which creates an added local responsibility.

For many years social-minded groups have been working toward the objective now attained—subsidized low-cost housing. But the legislation that makes it possible places responsibility squarely on the local communities. Are they willing to pay the price?

PICTURES IN THE NEWS



AIDING *the return of romance to railroading—to say nothing of improved service and more revenues—Rock Island Lines is putting a fleet of six shot-welded, stainless steel, diesel streamliners into service. Rock Island Rockets is their romantic-sounding name.*

THEY ARE REBUILDING *the Moffat Road. Maintenance engineer G. S. Turner, assistant to the president W. O. Colwell, and chief engineer W. C. Jones stop their inspection chariot on a tour of the extensive Denver & Salt Lake improvement program that will be described next week.*

UNION *or no union—A.F. of L. or C.I.O.—it is payday at Grand Coulee Dam.*

FIG. 1. SLUM CONDITIONS IN MEMPHIS. THESE HOUSES RENT FOR $1.50 PER WEEK.

A Yardstick For Slums

by ALFRED H. FLETCHER

Sanitary Engineer, Health Department, Memphis, Tenn.

A scoring system of slum classification developed by the Memphis health department puts a numerical value on housing conditions

TO ANALYZE the make-up of the slum areas of Memphis in order to map out a practical program of correction and redevelopment, a study of housing conditions was initiated early in 1936. Briefly, it is an attempt to place a numerical value or sanitary rating on each house, based on the per cent of perfection as compared with a set minimum standard house. From the ratings for each house an average sanitary rating for any block or group of blocks is computed. Finally, by considering the layout or design of the block (that is, the relation of dwellings facing streets to those in the rear, with some facing alleys) another factor, called the rear dwelling factor, is applied. From these data it is possible to arrive at a housing index for a block or group of blocks. Inspectors experienced in housing survey work collect the information, which is used primarily for computing the sanitary rating, but which can also be applied to other studies showing trends in vacancies, crowding, rooms for living units, and rentals for the various classes of slum areas.

In this study a slum is considered to be a group of dwellings that are, as a group, below a minimum standard necessary to support the good health and welfare of the occupants; when classified as to the degree of unfitness for occupancy these houses would fall in the very lowest category. Since there is no minimum standard agreed on by public health or housing officials an arbitrary standard was adopted for Memphis.

This defines the minimum standard house as one constructed reasonably tight to protect the occupants from the weather, and screened for protection against mosquitoes; provided with inside private washdown toilets, a water faucet and sink connected to the sanitary sewer; served by the municipal water supply; provided with adequate natural light and ventilation; facing a street and in a reasonable state of repair. Other conveniences, such as electricity, gas, hot running water, etc., might be provided but unless furnished for free use with the rent would not be used in many cases by the lowest wage earners, such as those making $30 a month or less. The latter, therefore, would not be demanded for a house to meet the Memphis department of health's minimum standard.

The key facts for judging the dwellings surveyed are: (1) Loca-

a	A TOILETS										B WATER SUPPLY								C CONDITION OF DWELLING										D MISCELLANEOUS												
b	Inside	Back porch	Outside private	Outside communal	None	Credit	Deduct	Difference	Family Units	Score: family unit	Inside	Outside private	Outside communal	None or unprotected private	Credit	Deduct	Difference	Family units	Score: family unit	Windows	Screens	Roof	Floors	Walls and ceiling	Chimney	Completely dilapidated	Credit	Deduct	Score per bldg.	Tenant occupant	Owner occupant	Units vacant	Size of dwelling by living units.	Population	Number of rooms	Persons per room *	Unit rent per week	Rear building, alley or between	Number of stories	Sanitary Rating	Families per dwelling	Weighted rating for families.
c	Credits										Credits								Credits										Credits												
	50	30	20	10	0						25	15	5	0										20											5						
d	Deductions for condition: Good = 0; Fair = 2; Poor = 3.																												Less than 1 person per room = 0; From 1 - 2 persons = 3; Over 2 persons = 5.												
e	30			2*	2	170	4	166	7	23.7										2	3	0	0	0	0	0	20	5	15												
f	Enter number of families provided with toilets indicating location and condition of, in the proper column, as per example above. Means 3 families using inside toilet in good condition; 2 families using outside communal toilet in fair condition, and 2 families without any toilet. Score: (3x50) + (2x10) = 150 + 20 = 170. Deduct 2x2 = 4. Difference = 166. Score per family unit = Net Credits ÷ no. family units. 166 ÷ 7 = 23.7 Score per family unit.										Enter number of families provided with water faucet and sinks, indicating location and condition of, in proper column. Scoring same as in toilet column.								Enter deductions in proper column. The credit for a good dwelling is 20 and deductions are made for unsatisfactory windows, screens, roofs, floors, etc.; as per example above. Means windows fair, screens poor, roof, floors, etc., were satisfactory.										*The full credit for "persons per room" is 5 and is given for 1 person per room or less. Between 1 and 2 persons per room is crowded and gets a credit of 2 points only. Over 2 persons per room is overcrowded and rates 0. The Sanitary Rating is a figure which is a fraction of 100; it represents the degree of practical perfection of sanitary requirements thrown around each family in the dwelling.												

Fig. 2. Tabulation sheet used by the Memphis department of health in applying a yardstick for measuring conditions in the slum areas of the city.

tion, condition and use of toilet; (2) location, condition and use of water and sink; (3) condition of screens, roofs, floors, walls, ceilings and chimneys; (4) the number of families provided for by the dwelling; (5) the number of persons housed per room; (6) the position of the dwelling on the lot (front or rear).

These factors, when assigned more or less arbitrary numerical values, with deductions for unsatisfactory conditon of the various items, give a picture of the degree of bad housing in comparison with the accepted minimum. The resulting figure for a dwelling is called the sanitary rating or factor. By grouping dwellings into blocks of dwellings, and combining with this figure the value referred to as a rear dwelling factor, a picture is obtained of conditions as they vary from block to block and area to area.

The scoring system is based on the allowance of such credit for the number (and in some cases the convenience) of water supply facilities and toilets, as well as for the general structural condition of the dwelling and for the number of persons housed per room. Deductions are made, depending on the degree of unsatisfactoriness of these items.

How the system works

The application of this system of scoring is outlined in Fig. 2. The four items graded are shown in line *a*. This includes subdivisions for toilets, water supply, condition of dwelling, and miscellaneous.

The individual items in each subdivision are shown on line *b*. For example, in the column headed "Toilets" locations are specified as follows: Inside, on the back porch, outside but private, outside but used by several families, and, finally, none.

On line *c* the credits that are allowed are shown. For example, an inside toilet will receive a credit of 50; a toilet on the back porch a credit of 30; an outside yard or communal toilet receives a credit of 10. The reason for the differences in grades allowed is based on past experience of the department of health.

On line *d* are shown the deductions that are made for the physical condition of the toilets, water supply or specific parts of the house.

Scoring a dwelling

A sample scoring of a multiple dwelling is shown on line *e* for illustration. Under "Toilets" are listed the scores as figured from a typical card and the explanation for scoring is given in the last paragraph of section *f*. The house and the family units in the house have received a score of 23.7 out of a possible 50 points. The score that each house makes depends largely on the number of sanitary facilities available divided by the number of families that use these facilities. In the illustration used, there are 5 toilets and the total score received by the dwelling when divided by 7 family units results in a smaller figure, of course, than if 7 toilets had been available.

The score made by a dwelling under column "Toilets," is added to the scores under "Water Supply," "Condition of Dwellings," and "Miscellaneous" for the total sanitary rating.

In order to combine the ratings for any group of dwellings so that a fair average for any block can be computed, the number of families in each dwelling is obtained. By multiplying the sanitary rating for each dwelling by the number of families in that dwelling, a weighted total sanitary rating is figured. All these total ratings for the dwellings in any one block are added together and the sum divided by the total number of families living in the block. The resulting figure is the average rating for the block.

In order to get the sanitary rating for any group of blocks, the sum of the products of the sanitary rating of each block multiplied by the number of families in each block is divided by the total families in all the blocks.

The housing index

Another factor taken into consideration in order to arrive at the housing index for any block or any area is the rear dwelling factor. For any

block it equals 100 minus twice the per cent of the family units in any specific block that do not face a street. This assumes that the worst condition will be 50 per cent of the dwellers living in the rear and 50 per cent facing the street. The housing index is then computed by taking three times the sanitary rating plus the value of rear dwelling factor and dividing by four.

After the blocks have been rated, they are classified according to their degree of degradation. The actual sanitary conditions within a slum vary from block to block. In general, the worst conditions are found in those areas in the center of the slums. Radiating outward from these cores are found gradually improved types of houses and sanitary conditions until an outer rim is reached which is referred to here as the blighted area.

The influence of the slum on a good area causes blight because as people move to get away from the slum the slum dwellers move into the better areas and thus gradually lower standards of living and of sanitation.

Conclusions from study

It is interesting to note that the blocks which received a rating of from 0 to 29 per cent (and they are the very worst blocks from the standpoint of bad conditions) show a high per cent of vacancies, a low average weekly rent per unit, a low average number of rooms per unit, a low average weekly rent per room, but a high average number of persons per room. There seems to be a definite relationship between these five items and the classification of blocks on the basis of degree of dilapidation. The charts in Fig. 3 illustrate this correlation for vacancies, average weekly rent per room and average persons per room.

This study indicates that the proper place for health departments to enforce housing codes for the purpose of getting improvements is in the better sections of the slums where reasonable rents are being paid. If this program is carried out, tenants who do not pay rents or who are paying fractional rents will be forced to move into the poorer section of the slums.

A certain amount of slum clearance can be carried out in the worst sections at the same time, but there

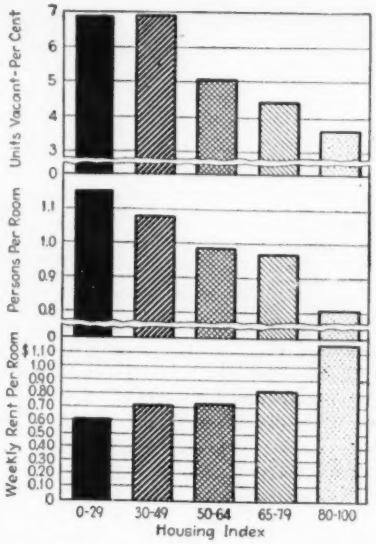


Fig. 3. Housing index correlations revealed by the slum area study.

will come a period of course when the per cent of vacancies in these worst areas will decrease to practically zero. This point will be reached when demolitions of dwellings and the increase of tenants in these areas through the forcing of non-paying or fractional paying tenants into these areas have proceeded far enough. It would seem then that municipal health departments can expect cooperation from property owners in meeting the requirements of a housing code down to a certain rental classification.

Below this level, enforcement will result in only one thing and that is demolition. It is this class of slum dwellers that should be taken care of in some other manner, and the only plan suggested to date is government-subsidized housing. Private capital will not be interested in housing this lowest wage earning group in minimum standard houses. These basic facts have not been recognized or admitted generally as yet.

The plan in Memphis at this time is to adopt and enforce a housing code strictly and impartially, beginning in areas where reasonable rents are or should be collected, and work toward the worst conditions and the lowest rents. When the point is reached where further enforcement will result in slum clearance and the per cent of vacancies reaches zero, then some form of subsidized public housing at present seems to be the only solution. The point where enforcement is met with clearance will vary in different sections of the country. The lowest rental figure for a minimum standard house in the South is possibly half of the corresponding figure in the North.

• • •

City Trailer Ordinances Surveyed

MOST of the trailer ordinances passed recently by cities indicate that they have an eye to the tourist trade, a new survey by the American Municipal Association shows, yet there is evidence that the trailerite, with his house on wheels, is also regarded as a possible permanent resident, whose activities must be regulated.

Large cities particularly are drawing up ordinances aimed specifically at the permanent resident. The A.M.A. report embraces 53 municipalities, ranging in population from 1,569,000 to less than 1,000. Eighteen states are represented.

Among the new laws relating to trailer residence, six of the ten cities over 100,000 which were studied include time limits for location in trailer camps. The other cities with residence limits are distributed throughout the 43 other cities listed, with Dennis, Mass., imposing one of the stiffest restrictions (90 days residence limit in any six-month period). Ocean City, N. J., is the most lenient, permitting trailer dwellers to remain 120 days in any 12-month period.

Sault Ste. Marie, Mich., though restricting general location to 90 days in any given six-month period, allows the trailerite to settle during winter months in excess of that limit, provided he can prove that he is gainfully employed and not likely to become a public charge.

Although occurring oftener in large cities, complete trailer regulation is not restricted to them. Smaller municipalities have found complete regulation expedient, because the trailer tourist often prefers the small town and village for his overnight stay. To prevent the mobile houses being used as semi-permanent residences, 16 cities prohibit the removal of wheels, or blocking trailers.

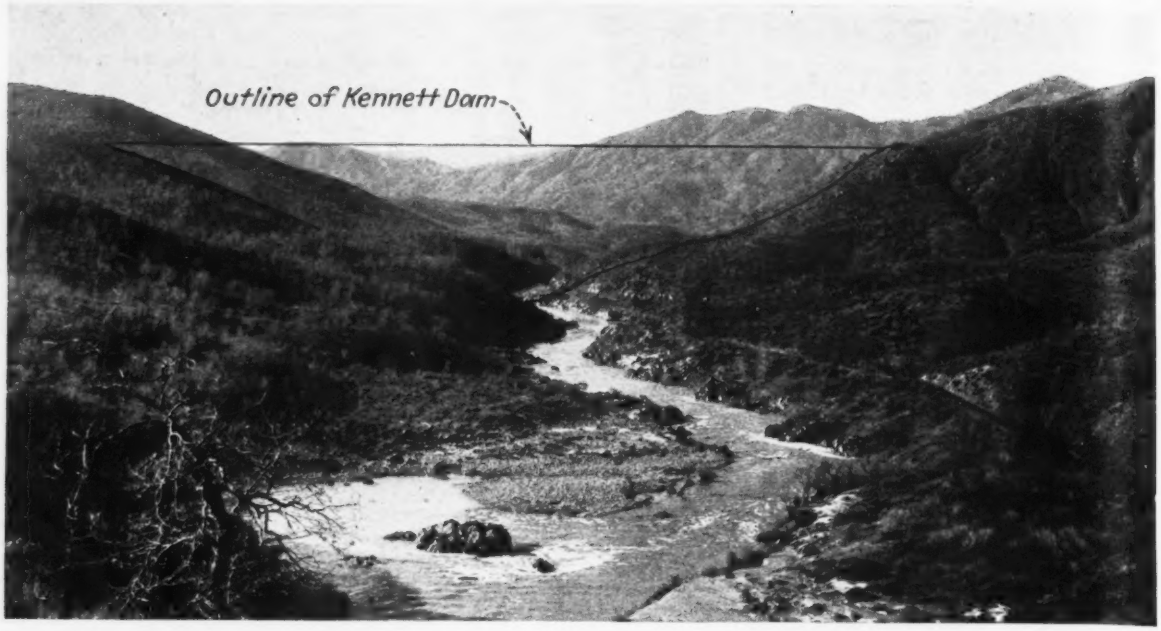


FIG. 1. KENNETT DAM SITE LOOKING DOWNSTREAM IN THE SACRAMENTO RIVER CANYON.

California's Long-Range Water Plan

Construction features of the Central Valley project, through which water stored on the upper Sacramento is to be pumped up the San Joaquin valley, include two dams, a power station, canals, and pumping stations

[To complete the sketch of the remarkable Central Valley project given last week, technical details of conditions and proposed works are given here.—EDITOR.]

RAIN and snow bring enough water into the great Central Valley of California to supply all its irrigated lands, but the rainfall is largely in the headwater area of the Sacramento River, in the North, while the lands of the Southern half, along the San Joaquin River, are short of water. Much of the Sacramento's runoff is wasted because winter floods flow into the sea unrestrained. A few hundred miles away some 400,000 acres in the south end of the basin, where rainfall is inadequate, have been drawing upon underground supplies for years, and steady pumpage has lowered the groundwater so much that the supply of thousands of acres of irrigated land already has failed. Unless there is early relief by importing the Sacramento's surplus water the investment in about half of this area may be completely destroyed. All the land that relies on underground storage is threatened.

To meet this situation a water conservation and development program almost state-wide in scope was proposed by state authorities after many years of study. Delayed by difficulties attendant upon an undertaking of wholly unprecedented size, the scheme took definite form very slowly, even while the need became more urgent and the drying up of orchards and vineyards gave dramatic proof of the menace to valuable adjoining lands now in full production. These emergencies speeded work on the plan for relief.

Last year the proposed scheme crystallized into an actual project and construction program when a partnership agreement between state and federal governments went into effect. The Central Valley project now is included among works being built by the U. S. Bureau of Reclamation. Its total cost estimated at $170,000,000, the project includes means of storing and conserving floodwater in the extreme north end of the basin, passing it down the Sacramento and pumping it up the San Joaquin River.

Essentially, the major engineering features of this unprecedented product of regional planning comprise: (1) Kennett Dam, forming a large storage reservoir on the upper Sacramento River from which regulated flows will be conveyed down the natural river channel as far as the delta; (2) Contra Costa Canal, a channel with pumping plants to carry

water from the delta into the upper San Francisco Bay area; (3) a series of pumping plants along the San Joaquin to transport Sacramento River water upstream from the delta into the upper parts of the San Joaquin Valley, and, (4) operating in conjunction with the preceding item, Friant Dam to form a supplemental storage reservoir on the upper San Joaquin River for the supply of canal systems leading therefrom into the irrigated areas of the South San Joaquin Valley.

As a federal project, the work depends on congressional appropriations. From this source some $11,400,000 already has been made available; construction is being carried on in the expectation of additional appropriations as funds are needed.

Extensive hydrological investigations were carried out to establish the character and magnitude of the immediately urgent water problems of the Central Valley. They dealt with surface water supplies in more than 50 tributary streams, the amount and distribution of underground storage, present use of both surface and underground supplies, the amount of water still available, and the salt-water-incursion menace to delta lands.

Much water now wasted

It was found that less than 20 per cent of the total seasonal runoff of the basin as a whole is actually consumed. A very large part of the remainder is wasted into the ocean by the winter and spring floods of the Sacramento. Illustrating the wide variations of stream-flow in the basin: the maximum seasonal runoff on different tributaries is from 2.6 to 3.2 times the average, while the minimum seasonal runoff is only 9 to 37 per cent of the average.

With the single exception of the upper Sacramento River, which receives a substantial volume of water from springs in vast lava beds to the northeast, all streams of the central basin have very small minimum flows, as is shown in the table on the next page. The possible combination of peak flows from several of these tributaries brings a flood threat to the lower reaches of the Sacramento, against which partial protection has been provided in the form of levees and bypasses. Maximum 100-yr. flood volume in the Sacramento River at Sacramento is estimated at 670,000 sec.-ft. (mean daily), the maximum combined floodflow of the Sacramento and San Joaquin Rivers at 780,000 sec.-ft.

Fig. 2. Key map showing extent of Central Valley project.

In the summer and fall months the low-water flow of both the Sacramento and San Joaquin rivers is fully utilized. Much of this low flow is return water from lands irrigated upstream. Measurements indicate that return flow ranges from 15 to 40 per cent of the gross stream diversions, and that 60 to 75 per cent of the diverted water returns during the irrigation season and is available for re-use downstream.

Between the cities of Red Bluff and Sacramento, total accretions of return flow to the Sacramento River during summer and early fall as observed in a 10-year period have averaged from 1,000 to 2,000 sec.-ft. During the same months the accretions of return flow on the lower San Joaquin River between Los Banos and the delta average from 100 to more than 500 sec.-ft.

In normal years the low-water flow of the Sacramento River from Red Bluff to the delta is sufficient to meet present irrigation drafts, but often there is not enough water left in the river to maintain navigation. In recent years the streamflow that reaches the delta during the summer and early fall months has been largely return flow.

The residual flow from the combined Sacramento and San Joaquin river systems into the delta ranges (1919 to date) at lowest water from practically nothing to about 5,000 sec.-ft., while the maximum flows have been as much as 363,000 sec.-ft. The maximum consumptive demand for delta irrigation is 3,700 sec.-ft. in midsummer, decreasing to a minimum of 400 sec.-ft. in midwinter. In addition, a flow of 3,300 sec.-ft. is required to keep salt water from the Bay out of the delta channels.

Based on records for the 1920-1929 period the additional water required to meet these combined needs would have averaged 451,000 acre-ft. per year (minimum 149,000, maximum 1,128,000).

Water supply and requirements

Irrigation uses account for more than 90 per cent of the water utilized in the Central Valley. Net irrigation requirements range from 1.50 to 2.75 acre-ft. per acre through the season, with maximum demand in

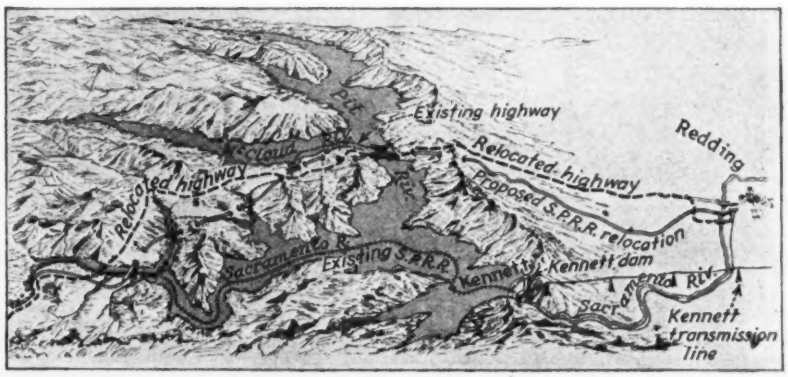


Fig. 3. Sketch of Kennett Reservoir which indicates the old and new locations for railway and highway.

summer. Of the three million acres of lands now irrigated, about one-third lies in the Sacramento Valley and about two-thirds in the San Joaquin Valley, while the precipitation has the opposite distribution, valley for valley.

Since 1889 the total annual streamflow of the entire drainage basin has averaged about 36,000,000 acre-ft., since 1919 about 25,000,000 acre-ft., two-thirds coming from the Sacramento River basin. Of the one-third that comes from the San Joaquin, more than 60 per cent is tributary to the northern San Joaquin valley, the part north of where the San Joaquin enters the valley floor. The average seasonal runoff tributary to the southern San Joaquin valley is less than 10 per cent of the total in the Central Valley basin.

As a final complication, most of the runoff occurs in the winter and spring months, whereas irrigation demand is greatest in summer, when there is no rain and little or no streamflow storage, therefore, is vital for this area.

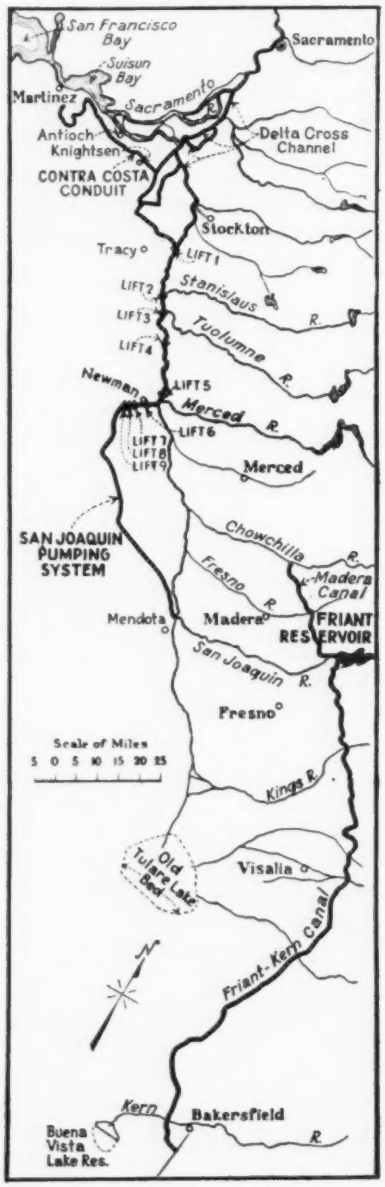


Fig. 4. San Joaquin Valley, showing the system of water delivery.

Aridity in the San Joaquin

During recent years the low-water flow of the San Joaquin River has been so fully utilized that only a small amount of water from irrigation return flow remained in the lower reaches. The minimum San Joaquin flow into the delta is often less than 1,000 sec.-ft., occasionally less than 500 sec.-ft.; in the dry year 1931 it was only 200 sec.-ft.

Surface waters tributary to the southern San Joaquin Valley are chiefly used in that area. The only surface outflow has been from the Kings River, which flows on a northeast-southwest ridge that extends across the San Joaquin valley trough—a ridge that confines on its southerly side the remaining waters of the south San Joaquin basin. Since the beginning of 1924, Kings River water has flowed northward from this ridge into the San Joaquin River in only six out of the thirteen years, and then only in relatively small amounts; in the other seven years the entire Kings River runoff has been consumed in the southern San Joaquin valley, by surface diversion or for replenishing the underground basins from which irrigation water is pumped.

More than half the irrigated area in the southern San Joaquin valley is at least partly dependent upon underground sources. Because of this pumpage the underground storage was depleted in the 1921-1929 period by 500,000 acre-ft. per season; in the dry year of 1924 the depletion reached 1,300,000 acre-ft. During this 8-year period the groundwater level in some places lowered as much as 85 ft. and over large areas it lowered 25 to 50 ft. The total amount of utilizable underground storage in the southern San Joaquin valley only amounts to 20,000,000 acre-ft.

Based on the runoff period 1921-1929, it had been estimated that 500,000 to 600,000 acre-ft. is the minimum yearly amount of additional (imported) water required by the southern San Joaquin valley. After 1929, however, a protracted period of subnormal rainfall and streamflow set in, and groundwater depletion was accelerated. It is now believed that the need for new water substantially exceeds the above amount, particularly if adequate provision is made for the large deficiencies of dry years and for overcoming the groundwater depletion that has been cumulative for years. The only source from which this supply can be obtained is the Sacramento's surplus.

Features of the project

For ten years past the California officials have studied how to supply the San Joaquin from the now-wasted floodwaters of the Sacramento. In the course of this study various auxiliary advantages of such a program have been considered, and what proved to be the most economic solution in each case has been combined in the Central Valley project as recently approved and accepted by the U. S. Bureau Reclamation.

Kennett Dam—The key unit in the entire development is the storage reservoir on the upper Sacramento River. At the outset, investigations

MAXIMUM AND MINIMUM MEAN DAILY FLOWS ON TYPICAL CENTRAL VALLEY STREAMS

Stream	Maximum. (Sec.-Ft.)	Minimum (Sec.-Ft.)
Sacramento River Basin		
Sacramento River at Red Bluff	254,000	2,400
Feather River at Oroville	187,000	600
Yuba River at Smartsville	111,000	71
American River at Fairoaks	120,000	5
Stony Creek near Fruto	29,300	—
San Joaquin River Basin		
San Joaquin River at Friant	38,800	54
Kern River at Bakersfield	16,100	82
Kings River at Piedra	46,300	67
Merced River at Exchequer	37,200	—
Mokelumne River at Clements	23,400	—

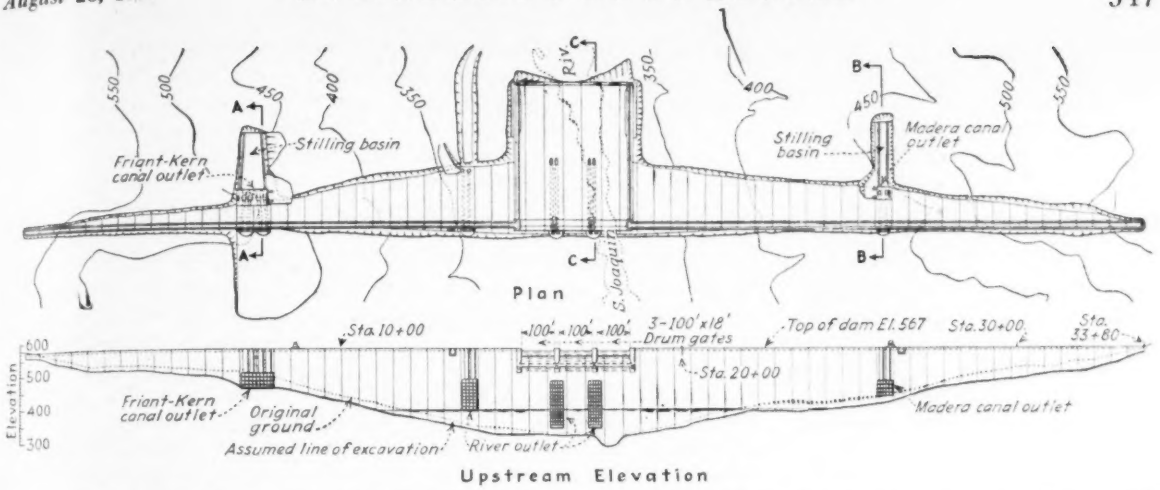


Fig. 5. **Friant Dam in plan and elevation. This dam will be used to supply irrigation water to the southern part of the San Joaquin Valley.**

in field and office were made on five dam sites, all north of Red Bluff. Promising sites were found at Table Mountain, between Redding and Red Bluff; at Baird, immediately below the confluence of the McCloud and the Pit rivers; and the Kennett site in the Sacramento River canyon, 13 miles above Redding. The bureau's consulting board concluded that a dam could be built at any of these three sites but that the Kennett site is best provided satisfactory arrangements can be made with the Southern Pacific Ry. for removing its tracks from the reservoir site.

Foundation exploration at the Kennett site by the bureau has included 5,663 lin.ft. of tunnels and shafts, 7,358 ft. of diamond-drill cores, and 187.5 ft. of borings taking cores 3 ft. in diameter. Studies of the dam section still are under way at Denver, but it is expected that plans will be for a straight concrete structure of gravity section at least 420 ft. high above low water to store 3,000,000 acre-ft. as a minimum. About 8 mi. downstream a small dam (Keswick Dam) is to be built for afterbay regulation, so that irrigation and power will not interfere with each other.

The 6,650 sq.mi. of mountain watershed above Kennett Dam site furnish about 6,000,000 acre-ft. of water per year (average for 1889 to the present; 1919 to the present, 4,500,000 acre-ft.). The minimum year's runoff (1930-31) was only 2,600,000 acre-ft., however. This watershed produces about 25 per cent of the total runoff from the Sacramento River Basin. Storage at

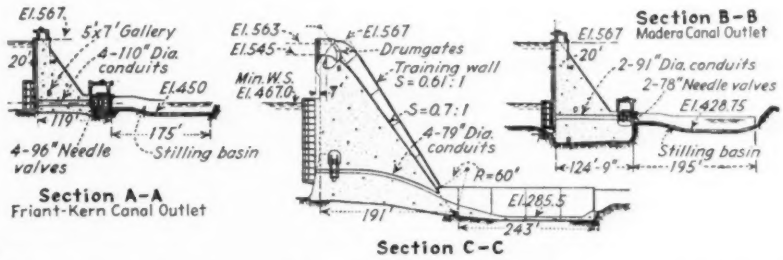


Fig. 6. **Typical sections of Friant Dam, which will have the unusual length of 3,380 ft. and a height of 250 ft.**

Kennett must serve more than one purpose. First of all it must take care of floods; from December to March, inclusive, a capacity of about 500,000 acre-ft. will be held empty to catch floods. The maximum 100-yr. floodflow will be decreased at Red Bluff from 303,000 to 187,000 sec.-ft. and at Colusa from 254,000 to 170,000 sec.-ft. This will afford increased flood protection to the lands in the Sacramento valley above the confluence of the Feather River.

Next, most of the water released from the reservoir will pass through turbines (totaling about 300,000 hp. or more in capacity) that will furnish power by way of a 200-mi. transmission line to Antioch, the power load center of northern California.

Finally, water released from the reservoir will be so regulated as to give: (1) a full supply to irrigate all lands having rights to Sacramento River water, (2) 6-ft. depth in the river channel for commercial navigation at all times as far as Chico Landing and later possibly Red Bluff, (3) a flow into the channels of the Sacramento-San Joaquin delta which, in combination with the flow of unregulated streams, will meet the full consumptive requirements of the delta plus enough to prevent salt-water incursion, a total of about 7,000 sec.-ft. in midsummer, (4) water supplies for industrial, municipal and agricultural use in the upper San Francisco Bay area, and (5) a water supply for the upper San Joaquin valley's irrigation requirements.

Contra Costa Canal—Water for municipal, industrial and irrigation purposes on the south side of Suisun Bay is to be delivered by 50 mi. of canal diverting from a channel of the delta near the town of Knightsen, about 15 mi. east of Antioch, and terminating near Martinez. The normal operating capacity in the initial section will be 275 sec.-ft. Except in the first four miles the canal will be lined with concrete. Four pumping plants will lift the water 170 ft. Tidal range at the canal intake is about 6 ft., average water level about 1 ft. above mean sea level. Fresh water is to be maintained at this canal intake at all times by releases from Kennett reservoir for salinity control.

San Joaquin Pumping System—To convey Sacramento River water in sufficient quantity into the San Joaquin River delta channels for meeting the needs therein and diversions therefrom, including water to be taken by the Contra Costa Canal and by the San Joaquin pumping system, artificial connections between the rivers will be made at the northerly end of the delta, (see delta cross channels in Fig. 4).

The San Joaquin pumping system will convey water upstream by a series of pump lifts and intervening natural and artificial channels, a distance of 150 mi. to an elevation of 160 ft. above sea level at a point near Mendota (west of Fresno). The maximum capacity of this system will be 3,000 sec.-ft. The lower 86 mi., extending from the vicinity of Stockton upstream to the mouth of the Merced River, will utilize the natural channel of the lower San Joaquin River. Five dams and pumping plants will raise the water in this distance to about El. 62. It is proposed that the dams be made collapsible to permit free passage of flood waters. The question of improving navigation on this stretch of the river has not been definitely settled. As the river will be canalized by the dams, locks would restore commercial navigation as far as the Merced River.

Leaving the San Joaquin River channel near the confluence with the Merced, the new water supply will be conveyed west of the river in an artificial canal built for the purpose and, for the most part, lined with concrete. Pumping plants will be required to lift the water at intervals. The southerly terminus is near Mendota.

Friant Dam—Near the southern end of this San Joaquin pumping system there are several large canals which now divert practically the entire low-water flow of the San Joaquin River for the use of lands in the northern end of the San Joaquin valley. Purely as a matter of economics, instead of lifting Sacramento River water an additional 300 ft. to make it available for use on the lands of deficient supply farther south, the Central Valley project contemplates exchanging Sacramento River water for certain waters of the San Joaquin River used near the southern terminus of the proposed canal system. By means of this exchange and the purchase of certain other rights to water now irrigating inferior grass lands, nearly the entire flow of the San Joaquin River can be made available for conserving and regulating a water supply for the southern end of the San Joaquin valley. This storage will be provided by Friant Dam on the San Joaquin River about 20 mi. north of Fresno in the foothills of the Sierra-Nevada.

Friant Dam will be a gravity concrete structure about 250 ft. in height, of the unusual length of 3,380 ft. The tributary drainage basin includes an area of 1,631 sq. mi.; the reservoir capacity will be 450,000 acre-ft. No power is to be developed at this dam; canals will divert directly from the reservoir and the flow will be entirely by gravity to irrigated areas north and south of the reservoir. Because the canals will divert at a considerable height above stream-bed, the net storage capacity which will be available for regulation will aggregate only 320,000 acre-ft.

Runoff at Friant has averaged about 2,000,000 acre-ft. per year since 1889 and 1,400,000 acre-ft. since 1919; in seasons of minimum flow the runoff has been between 400,000 and 500,000 acre-ft.

Madeira Canal—Leading northerly from Friant Dam to the Cowchilla River, Madeira County, a distance of 35 mi., the Madeira Canal will convey water from Friant reservoir to areas to the north of the upper San Joaquin River. The initial section of this canal will have a capacity of 1,000 sec.-ft.

Friant-Kern Canal—The large area to the south of Friant reservoir will require a larger and longer canal system; the initial capacity will be 3,000 sec.-ft. and the total length about 165 mi. Both the canals leading from Friant Dam will be concrete-lined.

Although not a part of the construction program, the underground storage available in the southern San Joaquin Valley is a physical adjunct of primary importance to the project. Subterranean storage capacity amounting to 20,000,000 acre-ft. within feasible pumping range can be utilized by controlled replenishment and extraction. Utilization of this storage capacity in conjunction with surface storage is considered absolutely essential to meeting the water requirements of the present irrigated lands in the southern end of the San Joaquin Valley.

Progress to date

Announcement of approval of the Kennett Dam site was made by John C. Page, commissioner, U. S. Bureau of Reclamation, on Jan. 25, 1937. The only proviso was agreement with the Southern Pacific Ry. on relocation of the 30-mi. section of its present main line (Shasta route) which follows the bottom of the Sacramento River canyon from Redding to Dunsmuir. Negotiations are now under way on this agreement. Final location of the new line has been completed and plans and specifications are being drawn.

An important state highway route (U. S. No. 99) also will require relocation. Surveys have been completed on the new highway location, which follows the east side of the river and crosses the reservoir at Pit River by a combined railroad and highway bridge. Tentative plans call for a double-deck bridge with the highway on the upper deck and the railroad below, 3,300 ft. long, with cantilever main span 902 ft. long 450 ft. above present water level. Designs are being prepared in the Denver office of the U. S. Bureau of Reclamation.

Acquiring water rights

On the San Joaquin River negotiations for acquisition of necessary water rights are under way; reports are that progress is favorable. Most of the grass-land water rights which are to be purchased are owned by Miller & Lux, Inc. and affiliated companies. A proposed contract for purchase of these rights has been submitted by the Miller & Lux interests and is being considered by the bureau.

Initial contracts for parts of the Central Valley project advertised early this year included, (1) the first 4 mi. of the Contra Costa conduit, and (2) construction of camp facilities at the Friant Dam site. Bids have been received and some awards have been made. Construction work on these initial contracts involves a total cost of about $300,000.

Lining the Lincoln Tunnel

Placing of interior concrete shell of the new vehicle tunnel at New York was complicated by the deep pockets in the iron lining, thin coverage over the ribs and numerous service facilities to be buried in the concrete

CONCRETE LINING of a large cast-iron tunnel departs from the normal tunnel-lining procedure and becomes a highly specialized operation. The work is made both difficult and tedious by the deep pockets in the iron segments, the thin coverage inside of the iron (often as little as 2 in.) and the presence of numerous pipe lines, power and light ducts, outlets of all kinds, and ventilation ports. In the past the lining procedure has been largely one of hand work. However, on the new Lincoln vehicle tunnel under the Hudson River at New York the contractor mechanized the concrete lining far beyond anything seen on previous similar jobs and thereby speeded up the work to a sustained progress of 240 ft. of completed tunnel a week.

The south tube of the Lincoln tunnel, extending from Weehawken, N. J., to midtown Manhattan, is nearing completion; the second tube, adjacent and parallel to the first, has just been started. In the south tunnel is a shield-driven section 5,900 ft. long, lined with standard cast-iron and cast-steel segments, 31 ft. outside diameter. This article describes the placement of concrete lining in the south tunnel shield section. Two previous articles have described the project as a whole (*ENR* June 17, p. 901) and the south tube shield driving (*ENR* June 24, p. 955).

Central concrete supply

A single concrete plant, located in the New York construction shaft at the east end of the shield section, supplied concrete for the entire section, and all lining operations were carried on progressively from this end. Both the batching equipment and the 1-yd. mixer were arranged in the shaft to permit gravity flow of all materials. Trucks dumped sand and gravel from the ground surface directly into hoppers with chutes leading to the batcher bins; finished concrete flowed from the mixer into cars or buckets at the tunnel floor.

Steam boilers in the shaft provided heat for water and aggregates in cold weather. Haulage to the forms was by narrow-gage trains pulled by storage-battery locomotives.

Lining by stages

Concreting from one end only, the contractor had to work out a system whereby the various lining operations would be continuous, yet so arranged that they would not interfere with each other. For convenience, and partly by necessity, the cross-section of the tunnel was divided into eight pours arranged in the following sequence: 1—invert for 7 ft. 9 in. each side of centerline; 2—lower haunch and floor slab, encasing floor beams; 3—drain gutters at sides of roadway; 4—curb and lower sidewalls; 5—middle sidewalls to 10½ in. above the spring line; 6—upper sidewalls to ceiling slab; 7—arch above ceiling slab; 8—ceiling slab and encasement of ducts on upper sidewall on one side see Fig. 1.

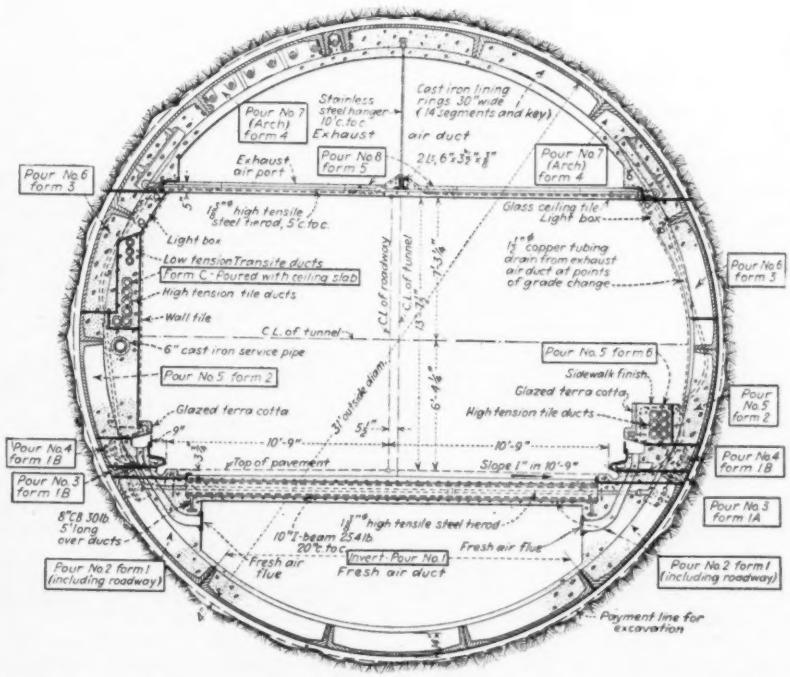

Pour No. 7 (Arch) form 4
Stainless steel hanger 10'c. to c.
Cast iron lining rings 30" wide (14 segments and key)
Exhaust
air duct
Exhaust air port
Pour No. 8 form 5
Pour No. 6 form 3
Pour No. 7 (Arch) form 4
Glass ceiling tile
Light box
Light box
Low tension Transite ducts
Form C - Poured with ceiling slab
High tension tile ducts
Wall tile
C.L. of tunnel
6" cast iron service pipe
Pour No. 5 form 2
Glazed terra cotta
Pour No. 5 form 6
Sidewalk finish
Glazed terra cotta
High tension tile ducts
Pour No. 5 form 2
Pour No. 6 form 3
Pour No. 4 form 1B
Pour No. 3 form 1B
Top of pavement
Slope 1" in 10'-9"
Pour No. 4 form 1B
Pour No. 3 form 1A
8"CB 30lb 5' long over ducts
10"I-beam 25 4lb 20'c. to c.
Invert Pour No. 1
Fresh air flue
Fresh air duct
Fresh air flue
Pour No. 2 form 1 (including roadway)
Pour No. 2 form 1 (including roadway)
Payment line for excavation

Fig. 1. Nine separate pours were necessary to complete the concrete lining of the Lincoln Tunnel. Forms were 80 ft. long, except for the ceiling slab, where two 120-ft. sections were used.

No forms were required for the invert pour except screed guides. On all the other pours single sets of steel forms in 30-ft. lengths were used, except that for the ceiling slab there were two forms, each 120 ft. long. To have arranged the several forms in adjacent or close formation would have resulted in undesirable congestion. Instead, the work was planned to spread out the units, spacing the forms being concreted some distance apart. Since the roadway slab was used as a base for the subsequent forms, roadway concrete was carried well ahead of the other sections to permit ample time for the concrete to reach adequate strength before being used. The invert was also kept some distance ahead of the roadway slab. The pouring schedule called for three pours a week in the 30-ft. forms and one weekly pour for each ceiling form, resulting in 210 ft. of lining weekly.

Invert and roadway

Beyond the point of usable roadway slab, the flying gangway used in driving the tunnel carried the haulage track at a level high enough to permit direct dumping from cars into the invert and floor slab. At the invert the concrete thickness is only 2 in. greater than the depth of the iron. As no forms were used for this section the concrete was mixed stiff enough to permit screeding to the curve of the tunnel bottom. Much spading was necessary to insure the complete filling of the iron pockets. The invert was placed in alternate sections 15 ft. long.

The roadway-floor cross beams, 10-in. 25.4-lb. I-beams, placed 20 in. c. to c., were erected on the first form, and the reinforcing bars were then placed. Short longitudinal beams spanning the fresh air ports were hung from the end of the roadway beams. The road slab surface was screeded to receive a brick paving later.

The second form, that for the gutter, was very shallow, and was used mainly to shape the gutter trough. A steel curb was fastened to the third form, its anchors being imbedded in this pour.

Wishing to avoid as much hand work as possible, the contractor devised traveling working platforms for the next two pours on the lower

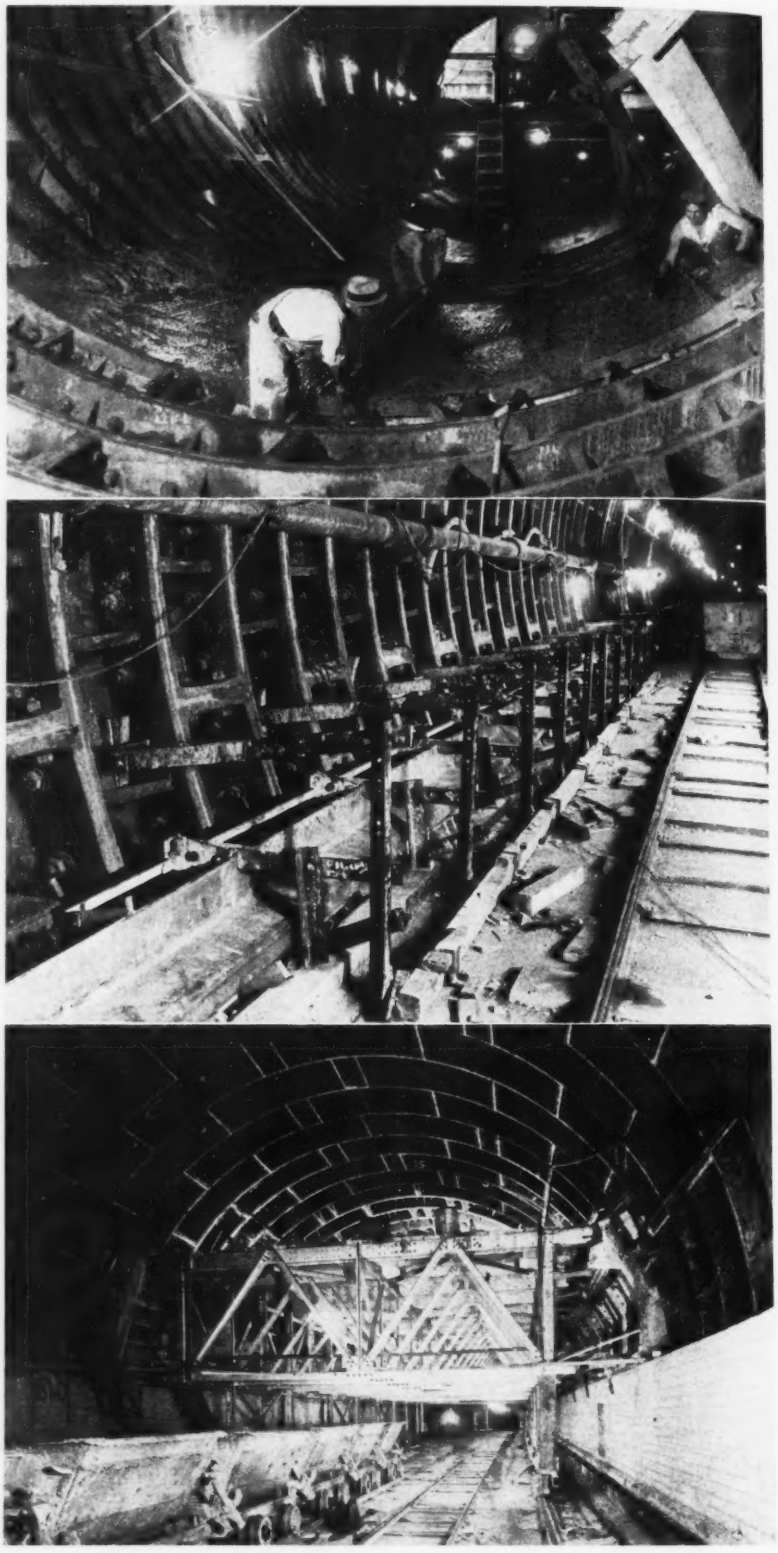


Fig. 2. Early steps in concrete lining. Top: Screeding the invert section, poured without forms; center: curb form, mostly the steel curb section; bottom: upper sidewall form making up the fifth pour of concrete. Placement of the concrete lining is a difficult job because of the deep pockets in the iron segments, the protruding bolt heads and nuts and the thin coverage over the ribs.

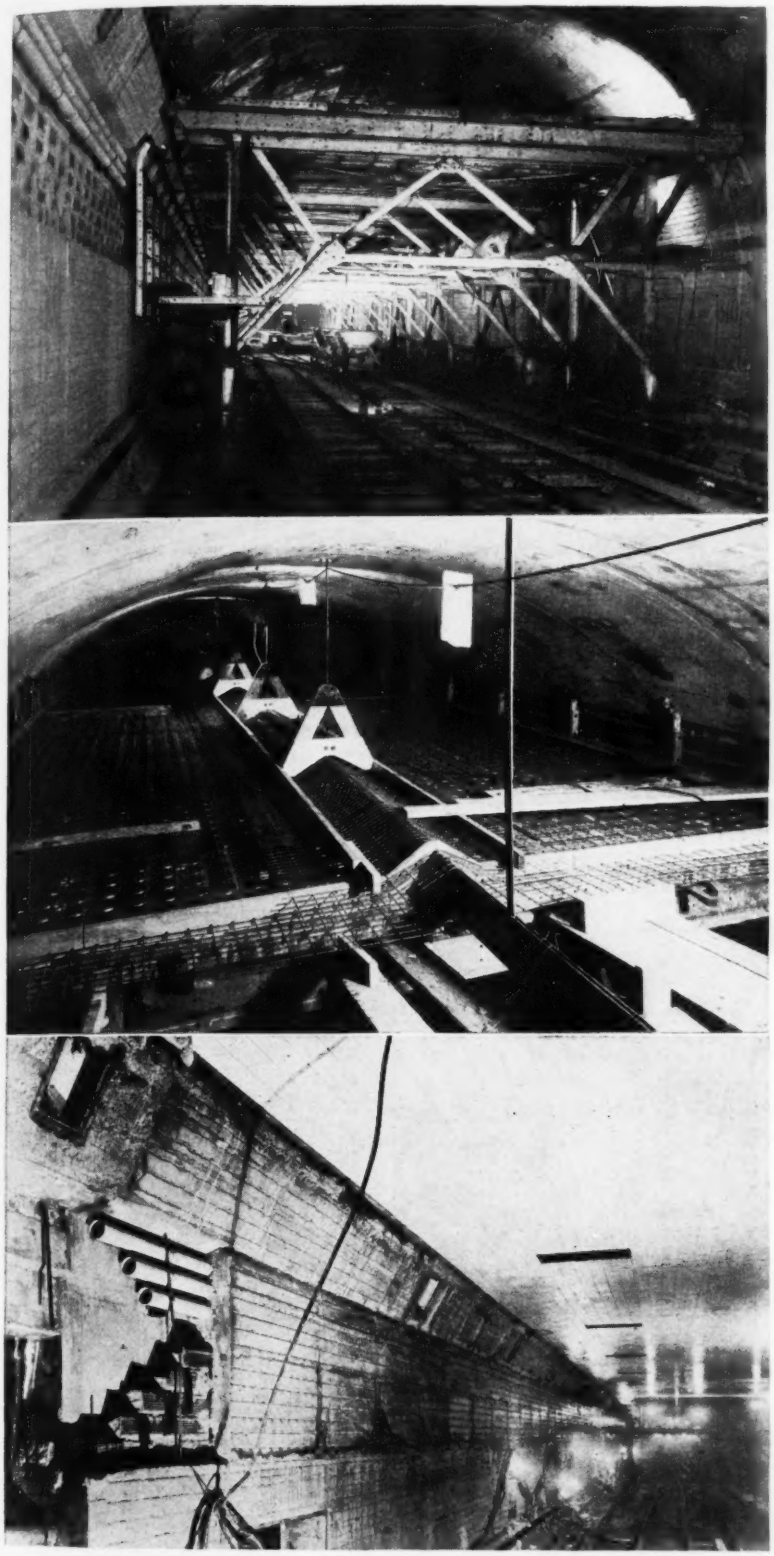


Fig. 3. **Final steps in concrete lining. Top: Ceiling slab form carrying a sidewall section for encasement of tile ducts; center: upper side of ceiling form ready for concrete, showing glass tile in place; bottom: section of tunnel with concrete lining complete. Use of glass tile in the roadway ceiling is an innovation in tunnel interior finishing. The tile units are gripped by raised copper sheets which bond to the concrete.**

and upper sidewalls. Trains of concrete in side-dump cars were run up long ramps to these platforms. Steel forms for these sections were carried on traveling steel frames, which also carried the working platform, rolling on tracks on the roadway slab. To secure a scored surface for the later application of wall tile for the final finish, horizontal wires were welded to the inside face of the steel form panels.

Placement of the arch concrete was a hand shoveling process, for no mechanical means have as yet been devised to fill the overhead iron pockets satisfactorily, especially as the distance between form and iron is only 2 to 4 in. The arch form, supported on a traveling gantry, was built up of removable steel panels, the concrete being shoveled through open panels. Within the form gantry was a high working platform, reached by a long ramp, up which the cars were hauled by a hoist line.

Getting the concrete into the arch pockets was a hard job, requiring considerable spading and ramming. There was no space in which to work between the form and the iron lining, and all operations had to be carried on from outside the panel openings.

Ceiling slab pumped

An innovation in this class of tunnel work was the placement of the ceiling slab by pumping the concrete. The ceiling form, most simple of all on the job, was built up of flat plates on a steel gantry. This form also included a section of upper sidewall, covering numerous tile ducts placed subsequent to pouring of the wall concrete. Beyond the form carriage was another gantry, under which the concrete pump was mounted, and which carried a hoist and the concrete discharge line that curved from the pump upward into the form. Concrete was delivered to the gantry in roller-bottom dump buckets, which were hoisted off flat cars to dumping position over the pump hopper.

At the start of a ceiling pour, the discharge line was carried to the back end of the form on wooden horses along one side of the steel hangars (centerview, Fig. 3). A short chute at the end of the pipe placed the flow close to final position,

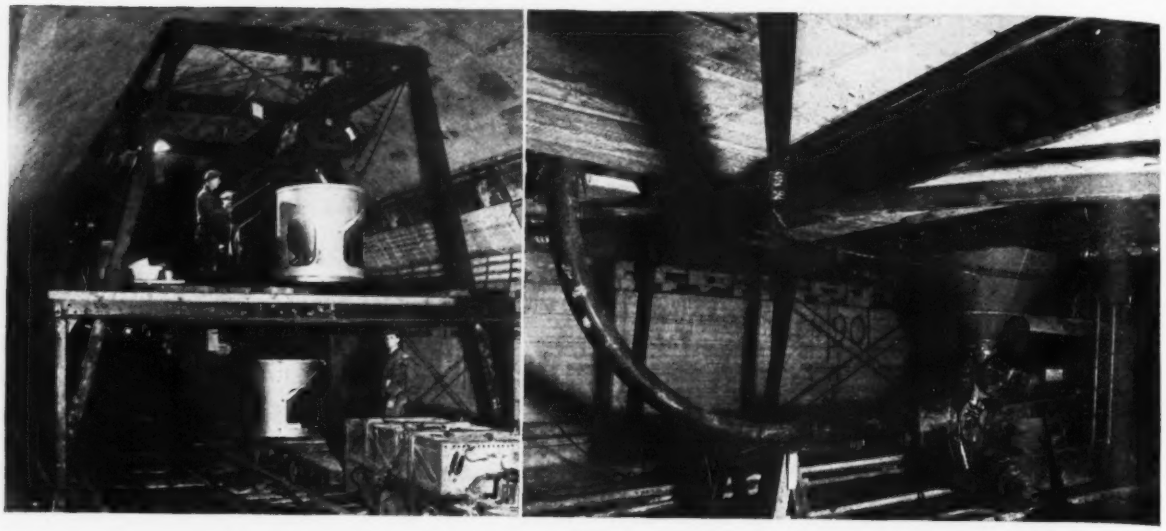


Fig. 4. Pumped concrete went into the ceiling slab. Here is shown the pumping and hoist equipment in action.

though some hand shoveling was necessary. As the work progressed toward the pump end of the form, sections of discharge pipe were removed.

A smooth finish was required for the top of ceiling slab. This was obtained by screeding and hand finishing.

For the first time in tunnels of this type a glass finish tile was applied to the under side of the ceiling. This tile, in 6x6-in. squares ⅜-in. thick, was placed along with the slab concrete. A heavy gummed paper was first placed gummed side up on top of the steel form, then the glue was wet with brushes and the individual tiles were laid on the fresh glue. The glue helped to hold the tile in place during placement of concrete. Each tile has a raised sheet-copper backing which grips the fluted edges of the glass, and forms an anchor by means of a raised hollow center. After the tiles were laid the joints were flushed from the top (back side) with cement mortar. This mortar was allowed to harden before pouring the slab, thus preventing concrete from working underneath the tiles or otherwise dislodging them. A heavy mat of reinforcing mesh was placed over the top of the tile after the mortar had hardened (Fig. 3).

Four days after pouring a slab section the forms were dropped and moved ahead. The paper was then sprayed with water and scraped off the tile and the glass surface polished to complete the ceiling slab.

The last pour to complete the concrete lining was that encasing the lower tile ducts, the top of which forms the sidewalk. A glazed terra cotta finish for this section was placed inside the form before pouring of the concrete. A corresponding, but much smaller, tile corner for the opposite side of the roadway was "buttered" on with neat cement after forms were stripped.

Of course it was impossible to completely fill the pockets of the iron segments in the arch section, and besides, there is a tendency for the concrete to pull away from the iron when setting. Therefore it was necessary to do an extensive amount of grouting of the arch. This work was done in advance of pouring of the ceiling slab. Lack of room between form and iron, and interference with hand placing of concrete precluded the advance setting of grout pipes, as is often done in tunnel work. Every grout hole had to be drilled after the forms were stripped.

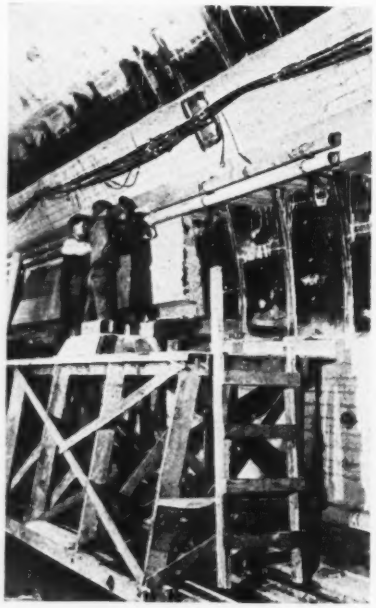


Fig. 5. Service facilities had to be worked into the lining in various ways. These men are placing electrical conduits between concrete pours.

From a traveling platform, two 2¼-in. holes were drilled by stoper drills into the pocket of every iron segment in the arch. This procedure naturally required careful spotting of the grout holes to avoid hitting the iron flanges. Into the holes were wedged 2-in. nipples, one of which was used for grouting, the other as a vent or bleeder.

A hand piston pump was used for applying the neat cement group and pumping was stopped when the bleeder pipe showed grout coming out. Following behind the grout crew a second crew pointed up the holes left by the grout pipes. Some 23,600 grout holes were required, averaging ten to a ring of iron lining.

Service facilities

No small part of the lining work was the installation of service facilities. These included water lines for fire protection and flushing, drains,

tile ducts for high tension power lines, Transite pipe ducts for low-tension power lines, tunnel lighting system, light outlet and other boxes, fresh and foul air ports and flues, telephone wires and wall niches for fire extinguishers. These various facilities had to be worked into the lining at various times. In some instances they were installed in advance of concrete placements, in others, such as the high-tension ducts, they were placed between successive pours, but in most cases they had to be built into the forms.

Direction

The Lincoln Tunnel is being built by the Port of New York Authority, for which O. H. Ammann is chief engineer, and E. W. Stearns is assistant chief engineer. Ralph Smillie is engineer of design and Chas. S. Gleim engineer of construction. C. L. Crandall is resident engineer in charge of the work herein described. The Mason & Hanger Co., New York, holds the contract for the driving and lining of the shield section of the south tunnel; it also has the contract for the north tunnel shield section on which work is just starting. Francis Donaldson is consulting engineer for the contractor, Miles Killmer is construction manager, and H. L. King is chief engineer. George B. Montgomery and W. R. Ury are superintendents.

Finding Weak Spots in Bridges

by Rudolf K. Bernhard

Consulting Engineer, Baldwin-Southwark Corp., Philadelphia, Pa.

As an advance on static and moving load tests, European engineers now apply induced vibration to bridges as a means of locating defects, especially of welded structures, before and while they are in service

Bridge testing to give assurance of safety has been going through a significant change in European countries within the last few years. For a long time past it was the rule in European countries to test a newly completed bridge by subjecting it to a test load before putting it into service, a practice not usually followed in America. A few years ago, however, higher speeds of railway trains became common, and at the same time welding found wide use to replace rivets in the connection of members and parts of members of bridges. Static testing was felt to be no longer adequate under these conditions, and dynamic testing was resorted to. The characteristic feature of this form of testing as now practiced is placing the bridge under induced vibration by means of an oscillator, and measuring its behavior under such action.

Up to about ten years ago the common practice in the case of a just completed railway bridge was to run a train on the bridge, representing as closely as possible the maximum locomotive and train loading for which the bridge was designed, and to measure the amount by which the bridge deflected under this load. In the case of a highway bridge, loaded trucks or steam rollers were used. By comparing the measured deflection with that calculated from the dimensions of the bridge and members certain conclusions could be drawn. For example, if a serious irregularity of the deflection curve was observed, or if the deflection was larger than that predicted from calculation, defects were looked for.

This method unfortunately gave no warning of a weak detail, since a small local weakness would not change the deflection perceptibly even though it endangered the security of the bridge. Also, the comparison with calculated deflection was vitiated by the influence of stringer participation in chord stress and by secondary stresses. When welding came into use the possibilities of trouble from local defects in the welding were recognized as much more serious than the corresponding risks in a riveted structure, and attention was turned to finding more certain methods of detecting bridge weaknesses.

The introduction of welding on a large scale in European continental bridge practice, roughly ten years ago, coincided with a trend toward higher railway speeds and heavier loads. At present Germany alone has several hundred welded bridges, including both railway and highway bridges, the former mainly plate-girder structures while many of the highway bridges are welded trusses. Due to the nature of welding, the danger of local connection defects is distinctly greater than in riveted bridges. If, for example, the welding at any one point in the bridge is defective by reason of imperfect adhesion, slag inclusion, burned metal, or by high shrinkage stress, a crack is likely to develop under load, which in due course would tend to cause failure of the bridge. Therefore the shortcomings of static load testing received close study, with a view to finding means of assuring safety by some more positive method.

Dynamic testing introduced

It was concluded that dynamic testing should supplant static testing, and many tests were made under moving loads, both deflections and stresses being measured. This pro-

cedure was nothing more than the application to regular service use of methods long previously applied in experimental research work on bridges, notably in the work of the British bridge impact committee. (1928 Report of the Bridge Stress Committee, London, England).

In 1928 dynamic testing was further developed by the experimental use of oscillators to vibrate the bridge. The behavior of the bridge under such vibration proved to be a much more sensitive indication of weaknesses in the structure than either moving-load or static tests. Within two years such vibration testing had virtually become established as a necessary supplement in the verification of bridge strength, and came into regular use by the German State Railways for welded bridges. Since then it has also found extensive use in Russia, Italy, Switzerland and France, though more for research purposes than for acceptance testing.

Value of vibration tests

Stated in simplest terms, the value of the vibration test lies in the fact that it measures the elasticity of the bridge, or its associated property, the degree of damping. So long as all parts of the structure are in sound condition and are not overstressed, the bridge will have a relatively high elasticity and a low damping; but points of overstress, and still more so loose joints or cracked welds, will absorb a certain amount of power during the vibration, which will increase the damping coefficient. When excessive damping points to the existence of some local defect of structure, including foundations, a search for the weakness can be made by thorough inspection, measurements of local stresses, and if necessary by X-ray examination of the welds.

The method can be applied to a structure of any size, new or old, finished or unfinished, or to any component part of the bridge. Static or moving loads may be combined with the vibration. It affords a means of comparing different types of structures, including concrete bridges. The many vibration tests carried out by the German and Swiss railway systems since 1928, on structures varying widely in size, material and type, have proved the simplicity, economy and usefulness of the method.

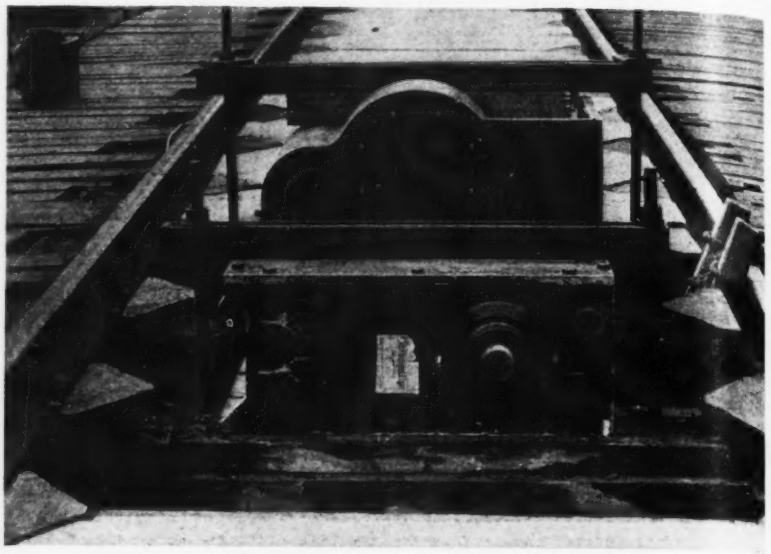


Fig. 1. In testing a bridge by vibration, an oscillator is attached to the structure and driven at a speed controlled by the rheostat (in foreground).

A bridge may vibrate in any direction when a moving load crosses it. In railway bridges such vibrations are caused by worn or flat car wheels on the moving load, poorly laid track, and unbalanced reciprocating parts of the locomotive. In highway bridges uneven road surfaces cause vibrations. These vibrations may result from single short blows or longer sinusoidal impulses and are more often irregular than regular. Studying the effects of the vibrations caused by the moving loads is a complex problem and presents many difficulties.

Induced vibration of the bridge by an oscillator does not solve these difficulties by reproducing the vibrations caused by moving loads, but rather subjects the bridge to a regular vibration which aids in locating structural weaknesses. The oscillator, (Fig. 1) consisting of two eccentric weights rotated in opposite directions (Fig. 2), applies regular sinusoidal forces to the bridge. Both the frequency and amplitude of the resulting oscillation can be varied by varying the speed and eccentricity of the rotating weights. The power input to the oscillator at the resonance frequency of the bridge as well as the power input throughout a range of frequencies is an index of the structure's elasticity and its dynamic characteristics. If structural weaknesses do exist, further supplementary investigations, such as measurement of deflections with a deflectometer and measurement of stresses with extensometers, are resorted to.

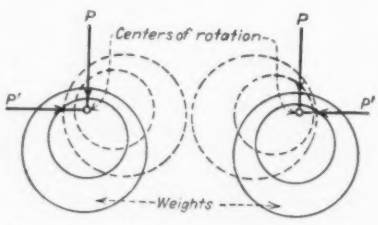


Fig. 2. In a bridge oscillator two eccentric masses rotating in opposite directions set up sinusoidal forces *P*, the horizontal forces *P'* neutralizing each other.

Equipment used in testing

The oscillator, which is similar to that originally used by the British committee, is motor-driven and is equipped with a rheostat speed control, a speed indicator, and a wattmeter. Oscillators can be built to operate at frequencies between 1 and 100 cycles per second and will provide impulses between 2 lb. and 20 tons. In testing a bridge, the magnitude of the oscillations is amplified by the induced vibration of the bridge itself. This amplification increases as the frequency of the oscillator approaches the natural frequency of the bridge and in some bridges may be as much as 40 times.

A special test car, developed by the

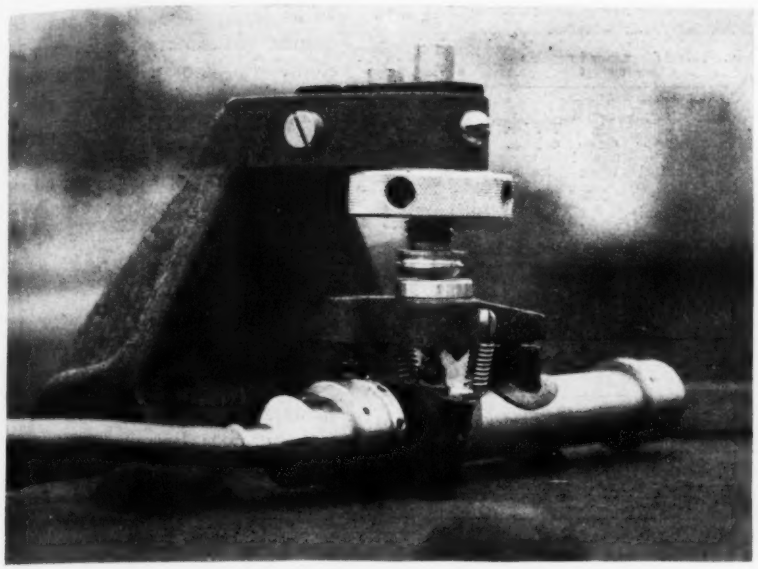


Fig. 3. **Stresses set up by the oscillator are measured by an extensometer and recorded by an oscillograph. The carbon-stack extensometer is here shown attached to the flange of a bridge girder**

German railroads, transports the entire equipment necessary for a bridge test by artificial vibration. The car contains photographic dark room, machine shop, generator, and living quarters for the test personnel, making test results immediately available in the field where investigations to locate any structural weakness can proceed immediately under favorable conditions.

In locating structural weaknesses by stress measurements the German railroads adopted as their standard instrument the carbon-stack extensometer (Fig. 3). The variation of stress in a bridge member as the bridge vibrates is recorded photographically by an oscillograph connected to the extensometer. Eight or more extensometers can be connected to one oscillograph, permitting eight or more different parts of the bridge to be observed simultaneously.

Testing a bridge

In testing a bridge by the induced vibration method, the oscillator is attached to the bridge (Fig. 1) in a position which will produce the desired vibration. Particular care is taken to avoid such power losses as those caused by energy dissipation through the foundations. The weights of the oscillator are then rotated, starting with low frequency and increasing the frequency by steps. The power demand of the oscillator at the various frequencies is measured, and a power input-frequency curve (Fig. 4) is drawn for the bridge being tested.

Maximum power demand of the oscillator occurs at the resonance frequency of the structure. Power demand data of tests, made on the oscillator when it is not attached to the bridge and is running free, are used to plot the no-load curve of the oscillator (Fig. 4). From the power input frequency curves, for the oscillator vibrating the bridge and also for the oscillator running free, the amplification of the bridge oscillations is determined.

This amplifying factor is computed by constructing line *AB* (Fig. 4) so

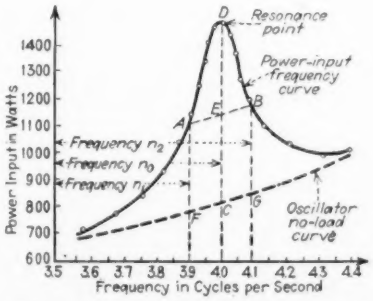


Fig. 4. **The amplifying factor and the damping coefficient computed from the power input frequency curve of the oscillator indicate whether there are weaknesses in the structure. This diagram is for a 310-ft. single track truss bridge at Vlotho, Germany.**

that it bisects *CD* at point *E* and makes *AF*, *EC*, and *BG* all equal. The amplifying factor depends upon the relation of the three frequencies n_1, n_2, and n_0 determined by the above construction of line *AB*, and is equal to

$$\frac{n_0}{n_1 - n_2}$$

The associated property of amplification, the damping coefficient, is equal to π times the reciprocal of the amplification factor.

Tests conducted by the German State Railways indicated that the usual welded structural steel bridge with all parts in sound condition, no loose joints, and no cracked welds, has a damping coefficient between 0.02 and 0.2. A riveted structural steel bridge in similar condition has a damping coefficient between 0.05 and 0.5.

Discovering weaknesses

If a vibration test of a bridge shows a damping coefficient greater than the range for that particular bridge it points to a power loss at some structural weakness, such as a loose joint, an overstressed detail or a cracked joint. A search for the structural weakness is conducted by thorough systematic inspection of all members and connections, measuring local stresses with extensometers, or in some cases by X-ray examination of the welds.

Possibilities of resonance

The test method of artificially vibrating a structure can also be used in studying another important phenomenon in the structural field, namely, resonance between vibrations of the live load and the bridge. The situation is analogous to that of a large mass (the bridge) connected to rigid abutments by springs, with a smaller mass (the live load) connected to the large mass by a spring. The characteristics of the individual vibrations of each of the two masses markedly affect the resulting joint vibration of the system. For example, a locomotive situated in the middle of a single-track railway bridge of the same weight and of ordinary span can produce a resulting vibration frequency which is seven-tenths of the natural frequency of the unloaded bridge. Studies of the natural fre-

NATURAL FREQUENCIES, DAMPING COEFFICIENT, AND AMPLIFYING FACTOR OF RAILWAY AND HIGHWAY MOVING LOADS.

	Load			Natural frequency in cycles per second				
	Type	Description	Condition of Loading	Vertical	Horizontal in direction of track	Torsion oblique to track	Damping coefficient	Amplifying factor
Railway Loads	Locomotive	Medium speed engine, on 5 axles	Boiler full, tank empty. Total weight = 62 tons	Under 2.0	6.6	8.7	0.51 0.71 0.90	6.2 4.4 3.5
	Locomotive	High speed engine on 6 axles	Full weight = 113.5 tons	Under 2.0	5.4	3.7	0.29 0.77	6.2 3.5
	Passenger Coach		Empty	Under 2.0	2.6		0.36	8.7
	Heavy freight car		Loaded with 55 tons of coal	6.3	5.9	5.8	0.37 0.53 0.33	8.5 5.9 9.5
Highway Loads	Automobile	30-ton truck with high-pressure tires	Empty	3.5		1.9	1.17 0.79	2.7 4.0
	Automobile	17-ton truck with low-pressure tires	11-ton load	4.1	2.1		0.34 0.50	9.2 6.2

quencies of bridges and moving loads for various types of vibrations have aided in determining the conditions under which resonance is of importance.

The oscillation of two coupled systems which have approximately coinciding natural frequencies creates what is known as beat. The amplitudes of the two masses increase one after another to a maximum and then decrease to a minimum. The time interval between two successive maxima is the period of the beat.

Particularly interesting is that oscillation in which a complete energy transfer occurs. In such a case, one mass vibrates and then comes completely to rest. While this is occurring the second mass reaches its maximum movement. Then the second mass comes to rest while the first mass is again reaching its maximum. Such a complete transfer of energy visualizes the approximate coincidence of the natural frequencies of both oscillation systems in an uncoupled condition. This complete transfer of energy cannot occur when the oscillating bodies possess damping characteristics.

Natural frequencies of bridges

Numerous bridge tests ("Impact in Steel Railway Bridges of Simple Span" by J. B. Hunley, A. R. E. A., Vol. 37, October, 1935) have provided the following approximate formulas for the natural frequencies of bridges subjected to the three main forms of oscillation:

For vertical oscillation, $n = \frac{300}{L}$

For horizontal oscillation, $n = \frac{370}{L}$

For torsional oscillation, $n = \frac{935}{L}$

In these formulas L is the bridge span in feet and n is the natural frequency of the bridge in cycles per second.

For ordinary bridge spans vertical oscillations range from 3 to 16 cycles per second, horizontal oscillations are slower and range from 2 to 14 cycles per second, while torsional oscillations are faster and range from 5 to 17 cycles per second.

Natural frequencies of loads

The natural vibration frequencies of locomotives, passenger coaches, freight cars and automobiles are affected by such factors as amount of the load carried, type and size of springs, and number of axles. For example, that part of the moving load supported on the springs of the car may move in harmony with the wheel trucks or its movement may be quickly damped by the springs. Several typical railroad and highway vehicles were vibrated separately when standing on solid foundations, and their natural vibration characteristics were determined. The data of these tests are tabulated in the above table.

The low natural frequencies of locomotives and passenger coaches and the high natural frequencies of heavy freight cars both fall outside the usual range of natural frequencies of bridges, but the natural frequencies of ordinary freight cars and automobiles are within the usual range, thus tending to give rise to resonance. All the live loads tested possessed a greater natural damping effect than has been observed on any bridge, however, and so usually do not amplify the magnitude of the bridge's oscillation.

Conclusions

If only the vertical oscillations of the bridge and its moving load are considered, the following conclusions can be drawn: Resonance is a distinct possibility in long-span railroad bridges of low natural frequency under heavy freight-car loads, but natural damping normally prevents high impact. In medium-span railroad bridges, which have a relatively higher natural frequency, resonance with the moving loads tested seems improbable, but unbalanced reciprocating weights of a locomotive may produce considerable oscillation. In railroad bridges of short span, and hence high natural frequency, appreciable resonance cannot occur because the moving load oscillates too slowly and unbalanced reciprocating parts of a locomotive cross the bridge in a very short interval of time.

In highway bridges the occurrence of resonance seems improbable under normal conditions for there are no unbalanced reciprocating parts, and the impulses caused by an uneven road surface are irregular. Road irregularities, however, can cause that part of the vehicle above its springs to vibrate considerably, and if this vibration is in harmony with that of the bridge resonance may result.

The tires of highway vehicles are especially favorable for a transfer of energy from the bridge and the setting up of the beat phenomena mentioned above. In other respects the division of structures into three groups of large, medium, and small spans, as was made for railway bridges, applies in the same way.

BIBLIOGRAPHY

"New Methods for Dynamic Investigations of Structures" by R. K. Bernhard. Transactions International Association for Bridge and Structural Engineering, First Congress, Paris, 1932.

"Dynamic Tests by Means of Induced Vibrations" by R. K. Bernhard. Paper presented at 1937 annual meeting of the American Society for Testing Materials.

"New Development in Electrical Telemeters" by O. S. Peters. American Society of Testing Materials, 1932, p. 592.

Five Classes of Fill in Large Dam

by J. D. Jacobs
Field Engineer, Walsh Const. Co., Oneonta, Ala.

Extensive plant required for crushing and placing a million cubic yards of rock of various sizes for Birmingham's Inland Dam

The type of structure to be built as Inland Dam for a new industrial water supply for Birmingham, Ala., was determined by competitive contract bids. Plans for both a gravity concrete dam and a combination earth and rockfill were submitted to contractors for bids in August, 1936, with the announcement that the cheaper type would be adopted. As a low bid of $1,685,231 for an earth and rockfill was about 8 per cent below the lowest bid for concrete, the fill type of structure was selected. The design is unusual in that five classes and sizes of fill, exclusive of riprap, are required, including a million yards of rock of which two-thirds must be mechanically crushed, and 600,000 cu. yd. of compacted earth.

This large amount of various classes of material necessitated an extensive and elaborate quarrying, crushing and screening plant, and further requires a careful schedule of procedure on the part of the contractor to properly and efficiently place the different fill sections. River diversion, spillway and outlet works are also of interest.

The dam is on the Blackburn Fork of Warrior River 35 miles north of Birmingham. The drainage area above the dam consists of 70 sq. mi. of rough country, and a rapid run-off results in a flashy stream whose flow fluctuates from almost nothing to 10,000 sec.-ft. The dam, 1,100 ft. long and 195 ft. high, will create a reservoir of 68,000 acre-ft. capacity. Arrangement of materials in the fill is shown in the cross-section Fig. 2. A brief description of the industrial water supply project was published in *ENR* Apr. 22, 1937, p. 591, and contract unit prices for the dam were published Nov. 12, 1936, p. 701. The dam will be completed early in 1938.

Diversion of the stream during the placing of the fill is accomplished through a 20-ft. concrete lined tunnel. A 22-ft. circular shaft drops into the outlet leg of the tunnel from a concrete spillway structure on the hill adjacent to the east flank of the dam. The spillway, shaft and tunnel will be the overflow outlet from the reservoir. The sole purpose of the shorter inlet leg of the tunnel, which intersects the outlet leg at a point 60 ft. downstream from the shaft, is for diversion of the river during construction. When the dam has been raised to an elevation at which storage can be started with safety, this inlet section will be closed by a concrete plug at the point of intersection.

An additional safeguard against the overtopping of the fill is an emergency spillway channel around the west end of the dam. At the inlet of this spillway a dirt fill above a concrete weir acts as a fuseplug to be washed out should the reservoir level rise to within 10 ft. of the crest of the dam. A sandstone ledge forms the floor of the emergency spillway for its upper 700 ft. and a concrete retaining wall on the side adjacent to the dam will prevent erosion of the fill.

The 60-in. steel pipe line, which conducts the water for 30 miles to the distribution system in Birmingham, originates in a reinforced concrete intake tower upstream from the

Fig. 1. Start of work on Inland Dam. Extensive benching of the west abutment was done by steam shovels and trucks.

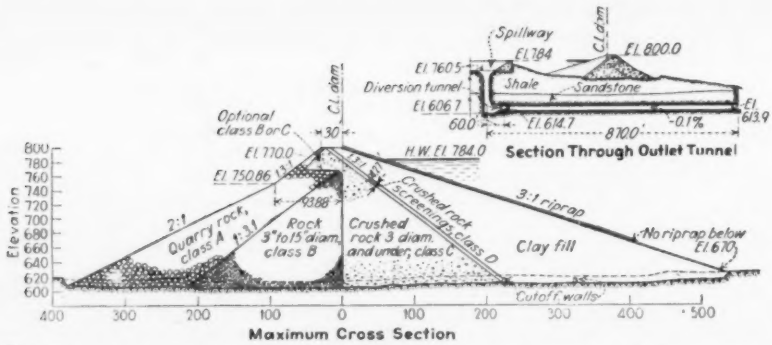


Fig. 2. Unusual classification of materials requires an extensive plant to prepare the various sizes of rock. Nearly half the volume of the fill will be crushed rock.

dam on the west side of the valley. The base of the tower and minimum pool level is 107 ft. below the high water level in the reservoir. Through the dam the steel pipe is trenched into the sandstone and encased in concrete. A pumping plant at the dam will provide water at times when the demand exceeds the gravity flow from the reservoir.

Two concrete cutoff walls prevent percolation of water along the plane of separation between the fill and the natural rock. The longer of these extends across the valley from crest to crest and follows the upstream toe of slope of the rock fill. A shorter wall extends up each side of the valley to 80 ft. above the stream bed. These walls are of plain concrete, averaging 2 ft. thick and 5 ft. high, founded on solid rock or firm shale.

Tunnel construction

Since the contract stipulated that no fill could be placed in the stream bed until the water had been diverted, the first phase of construction was

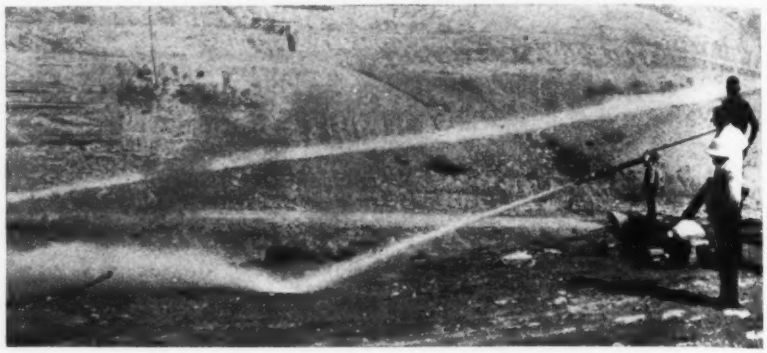


Fig. 3. Overburden was stripped from spots inaccessible to the shovel by a hydraulic giant.

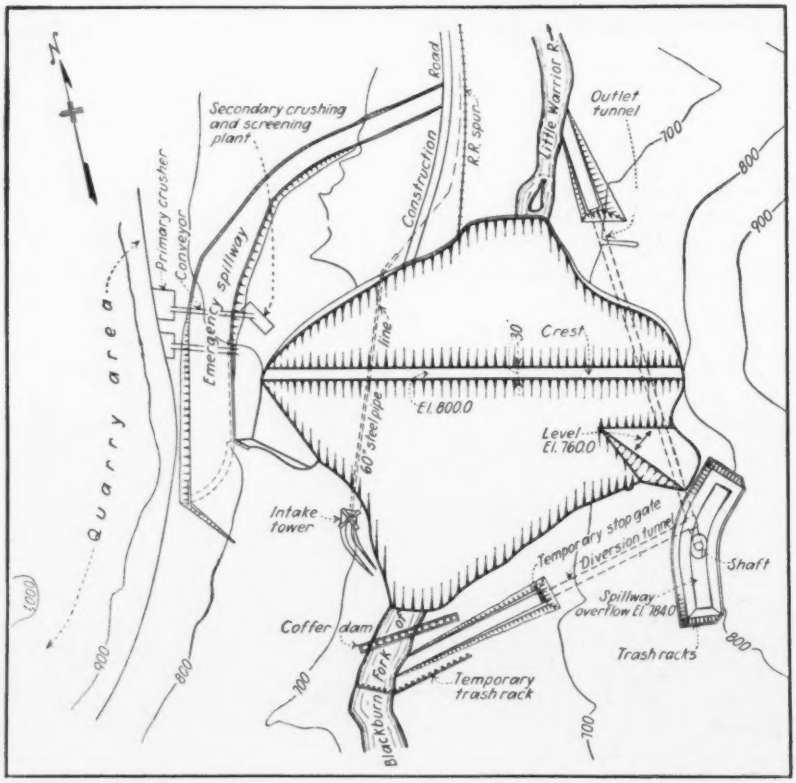


Fig. 4. It's a down-hill pull from quarry to crushers to fill for most of the rockfill material. This plan shows the relation of the various features of the project.

to drive the 1,300-ft. diversion tunnel. As soon as the open-cut rock excavation for the portals was finished the two legs of the tunnel were headed into the hill toward their intersection, through a fine-grained sandstone. The rock was drilled in 8-ft. rounds with automatic-feed drifter drills mounted on a wooden drill carriage. The holes were loaded with gelatine powder and shot with electric caps in delays up to ten. Good fragmentation was obtained with very little serious overbreak of adjacent rock.

Mucking was done by a mechanical mucker loading into side dump cars on a 36-in. track. Trains were pulled with gasoline dinkeys. Because of the shortness of the tunnels and the installation of a ventilation system, no trouble was experienced from fumes from the dinkeys. Muck was hauled to a storage dump, from which it was later reclaimed and crushed into concrete aggregate.

Very little timbering was needed for the support of either leg of the tunnel, but as a precaution two or three sets were placed at each portal. These, and a few doweled transverse roof beams in a portion of the inlet

leg where the roof appeared questionable, were the only supports required in the tunnel. The tunnels were practically dry.

Shaft work

The spillway shaft, 150 ft. deep, was sunk simultaneous with the driving of the tunnels. Through the first 88 ft. firm gray shale was encountered in which the excavated diameter was 25 ft. After the basal sandstone was entered the size of the hole was reduced to 24 ft. Mainly for the psychological effect on the workmen, the shale portion of the shaft was supported with segmented rings of 10x10-in timbers spaced 8 ft. apart. This timbering at no time took any pressure and was removed prior to pouring the concrete lining.

Drilling in the shaft was done with hand jackhammers. Rounds 4 ft. deep were pulled and the rock was hand mucked into shaft buckets, hoisted by a diesel crawler crane at the surface. Because the shaft sinking was done during the rainy season, a considerable quantity of water accumluated in the bottom. To dispose of this a small reciprocating steam pump actuated by compressed air was kept operating in the shaft during the drilling and excavating operations.

The shape of the finished tunnel is a circle 20 ft. in diameter with a 10-ft. chord forming the invert. The concrete lining was not started until after the excavation was finished. First the invert slab was poured for the full length of the leg under construction. When it had set sufficiently, upon it were laid the narrow-gage track and the 94-in.-gage form rails.

Fig. 5. All of the coarse and much of the fine aggregates for concrete are manufactured in this crushing and screening plant. Proportioned aggregates go by belt to the mixer plant in the background.

The arch form was constructed in a section 50 ft. long, with wood lagging bolted to steel ribs and frame. The form was collapsible and mounted on wheels to enable it to be rapidly moved ahead for each pour. A setting period of 24 hr. was allowed after each pour before the forms were released to be reset.

Concreting methods

The arch concrete was placed by a pneumatic gun mounted on a traveling gantry on the form rails. Up to the springline the pours were made through doors in the form. The remaining half of the arch was shot through a steel pipe along the crown of the form. By moving the gantry back and forth the concrete was placed in uniform horizontal layers as required by the specifications. In the final filling of the arch it was found that best results were obtained by keeping the discharge end of the pipe buried several feet in the fresh concrete, although the excessive pressure which resulted therefrom required a considerable amount of strengthening and rebracing of the forms. Thickness of the concrete lining was specified at a 6-in. minimum in the inlet leg of the tunnel and 12 in. in the permanent outlet leg. Concrete was hauled in 1-yd. buckets from the central mixing plant.

The concrete lining in the shaft was poured in 10-ft. lifts in wood forms built in quadrants. These forms were raised and set by a crane at the top of the shaft. The concrete was trucked from the plant and the buckets were

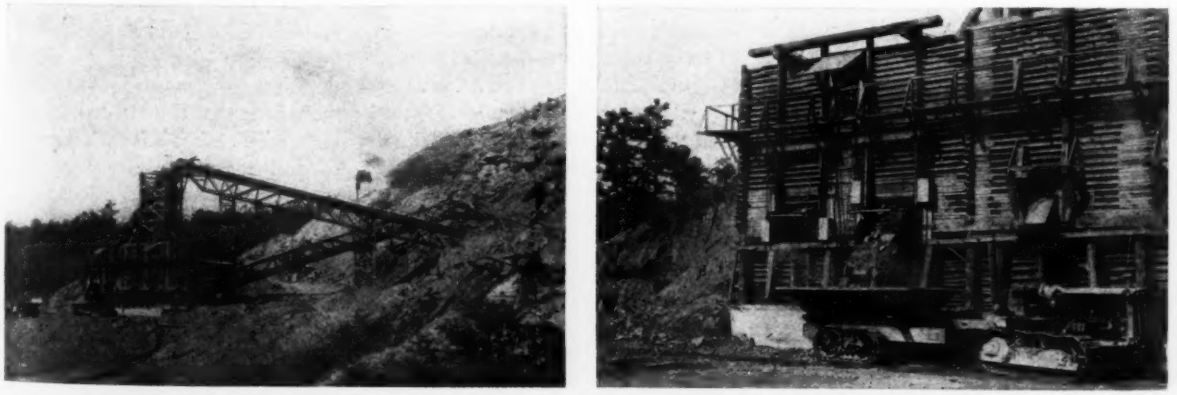


Fig. 6. A million yards of rock will be prepared in various sizes in this plant for the different fill sections. The quarry is up the hill to the right in the lefthand view.

lowered into the shaft with the crane. The concrete thickness was 18 in. minimum in shale and 12 in. in sandstone.

Some complicated wood formwork was required for the streamlined elbow at the intersection of the shaft and tunnel and also at the top where the vertical tube of the shaft funnels out into the floor of the spillway. These portions of formwork were carefully laid out on a working platform and built up in sections of a size that could be conveniently hoisted into place. Due to the complicated curvature of the forms, no reuse was possible and the formwork was destroyed and torn out with a crane after the concrete had set.

The spillway above the shaft consists of a concrete trough formed by the hill on the back and a 20 to 24-ft. high gravity dam section along the front and ends. A 3-ft. thick concrete slab doweled into the rock forms the spillway floor. The 8,000 cu.yd. of concrete for the spillway structure were transported by truck, and handled by crane and bucket.

A steel trashrack along the open sides of the spillway will keep logs and floating debris out of the shaft.

Aggregate and mixing plant

All concrete is manufactured in a central mixing plant located in the valley below the dam. Two 1-yd. mixers are used, fed by manual batchers under the aggregate bins adjacent to the mixing plant, the proportioned materials being conveyed by belt to a hopper above the mixers. Bulk cement is received in boxcars, unloaded by a power shovel and stored in a 500-bbl. steel silo above the mixers.

Because there are no deposits of river gravel in the vicinity the contractor found it economical to install a crushing plant to manufacture his coarse aggregate. Material finer than ¼ in. is passed through a cone type hydraulic classifier to remove the extreme fines. The resulting product is a sharp, well graded concrete sand. It has not been possible, however, to obtain a sufficient amount of manufactured sand without unbalancing the plant output, and consequently it is necessary to supplement the plant sand with a river sand shipped in by rail. Equipment in the aggregate plant consists of a 12-in. gyratory primary crusher, a smaller gyratory fine-reduction crusher used as a secondary, a three-deck rock screen, a two-deck sand screen, the sand classifier and necessary belt conveyors and bucket elevator.

Open cut excavation

While the tunnel work was in progress the excavation of the fill area was carried on. The specifications provided that the overburden be stripped to sandstone or firm shale over the area to be covered by the rock fill. In the clay fill area it was required that the natural ground be stripped to virgin clay or solid rock. The bulk of the stripping was done by steam shovels and hauled in crawler wagons to the waste dump. Some of the more accessible material was moved with 12-yd. carryall scrapers pulled by crawler tractors.

The lower portion of the valley slopes so steeply toward the stream bed that neither shovels nor scrapers could be used for stripping. To avoid extensive hand labor the contractor installed a 1¼-in. hydraulic sluicing nozzle and a high pressure centrifugal pumping system. The results of the sluicing have been very satisfactory, not only in removal of dirt but also in knocking down loose rocks and tree stumps from the ledges.

Quarry and crushing plant

The quarry for the fill rock is above the west abutment of the dam in a 100-ft. thick stratum of sandstone that forms the rim of the valley. The rock is drilled with 5-in. well-drill rigs, and the holes are loaded with high-strength gelatin. Detonating fuse is used for blasting.

Two 4-yd. steam shovels are in use for loading the rock in the quarry. Material is hauled to the crusher plant in 13-yd. wagons drawn by tractors. The quarry-run rock is hauled directly to the fill in quarry wagons and in 8-yd. motor trucks.

To obtain the large output capacity of crushed rock of the fill, an elaborate crushing plant had to be installed. This plant is in two units, consisting of a primary breaker at the edge of the quarry and a secondary crusher with screens and storage bins 200 ft. east of it near the west abutment of the dam. Belt conveyors connecting the primary and secondary units are carried on bridges over the emergency spillway in order that construction activities in that area can be carried on without interfering with the plant.

Rock coming from the shovels to the crusher is dumped into a hopper at the outer edge of the quarry floor. In the bottom of this hopper is a sturdy rock feeder of the apron type which delivers the stone to the mouth of the 48x60-in. primary jaw crusher. By means of push button control, an operator stationed at the feeder maintains a uniform flow of rock to the crusher and prevents overloading.

The output of the primary crusher is discharged onto another feeder which loads it on the 36-in. conveyor belt to be carried to the top of the secondary plant. From this belt the rock falls onto a bar grizzly which delivers the larger stone directly to the 3-to-15-in. bunker, thereby protecting the vibrating screen beneath it. The upper of the two decks of the screen is 3-in. mesh wire cloth, and material passing over it is delivered into the 3-to-15-in. stone bunker. The ½-to-3-in. stone off the bottom deck of the screen is delivered to its bin beneath. The fines which pass through the ½-in. mesh bottom deck of the screen go into the screenings bin.

The secondary crusher, a 20-in. gyratory, obtains its feed through the side of the 3-to-15-in. bunker. Its output is fed back by means of a 24-in. belt onto the 36-in. belt at a point near the discharge of the primary breaker, to make another trip to the screens for re-sizing.

The crushed rock is drawn out of the 3-to-15-in. bunker through two 60-in. square openings in the side and the drawoff is controlled by pneumatically actuated hinged chute gates. The smaller sizes of rock are withdrawn through 24-in. square standard undercut bin gates, also pneumatically operated. One man on a balcony above the gates controls the loading of the trucks which transport the crushed rock to the fill.

Clay fill

At present the rock fill has not progressed far enough to allow the

clay fill to be started. The plan, however, is to transport with carryall scrapers that portion of clay located within the economical working distance of these machines. The remainder will be hauled in dump trucks loaded by a shovel or dragline. The clay fill is to be brought up at a uniform level and placed in thin horizontal layers, not exceeding 8 in. thick. A five-roller sheepsfoot tamping unit pulled by a crawler tractor will be used for compacting the clay. From an elevation below minimum pool level to the crest of the dam the clay will be riprapped with quarry stone to 18 in. minimum thickness.

Supervision

The project is being financed by a PWA loan. The work for the city is being handled under an engineering commission consisting of: J. D. Webb, city engineer, chairman; O. G. Thurlow, and A. Clinton Decker. A. C. Polk is executive engineer in responsible charge of the project for the commission. The design work is handled under Col. Polk by H. J. Petersen, designing engineer. H. F. Peckworth is the resident engineer for the city at the dam and J. I. Combs is chief inspector. For the Public Works Administration, Wendell S. Merick is the project engineer, W. G. McConnel, supervising engineer, and R. W. Skidmore, inspector. The general contract for the dam is handled by the Walsh Construction Co. of Davenport, Iowa. For the contractors, Thomas Madigan is general superintendent and the writer is job engineer.

Wisconsin Sanitation Advances

Sewage disposal and water supply improvements in many communities furthered by federal funds during last three years

PUBLIC health and sanitation in Wisconsin have benefited by federal funds with which were undertaken 87 projects in 1936, 140 in 1935 and 122 in 1934. PWA projects amounted to $22,000,000 according to L. F. Warrick, state sanitary engineer of the State Board of Health, in a review prepared on request of Leo J. Voell, state director, PWA.

The $4,600,000 200-m.g.d. filter plant for Milwaukee, to be completed next year, is the largest project. Other cities benefiting from waterworks improvements are Oshkosh, Eau Claire, Racine, Stoughton, Two Rivers and Elkhart Lake.

Sewage interception progress

Greater progress than ever before has been made in sewage interception and treatment. On Jan. 1, 1935 there were 236 sewerage systems of which 120 had treatment plants. The population served as of 1930 was 1,727,000 of which 57 per cent were provided with disposal facilities. Now 260 cities with a computed population of 1,751,000 have sewers and there are 168 plants treating 76.5 per cent of the sewage.

Stream clean-up activities (*ENR* Aug. 27, 1936, p. 310) had provided by the end of 1935 primary or tank treatment for the 33 cities wherein live two-thirds of the 300,000 people on the Rock River drainage area. Similar progress has been made in the Illinois-Fox drainage area. The $1,318,000 interception and treatment facilities being installed for Sheboygan and the intercepter for Sheboygan Falls carrying sewage to the Kohler disposal plant will provide at least primary treatment for all the Sheboygan River district.

With the completion of projects started in the Fox River Valley, all large cities except one will have at least primary treatment. Five plants will employ chemical precipitation. Two are to be equipped for sludge dewatering and incineration.

Prior to the advent of the PWA the only municipality in the Lower Fox River Valley providing sewage treatment was Fond du Lac. All other communities were discharging raw sewage into Lake Winnebago and the Fox River. The industrial wastes alone in this area are equivalent to the sewage discharged from a city of 1,000,000 people.

Green Bay area

During the last four years Green Bay and the metropolitan area surrounding DePere, Kaukauna, Little Chute, Appleton, Neenah-Menasha and Oshkosh have completed or are constructing modern sewage treatment facilities. Prior to the construction of the treatment plants it was necessary in all of these municipalities to carry out an extensive and expensive intercepting program to convey the sewage to a site for treatment. Upon the completion of this program there will have been spent for elimination of stream pollution in this valley $5,000,000.

The provisions for sewage treatment at Oshkosh and Neenah-Menasha will materially reduce the load on the existing water purification plants at Oshkosh and Appleton, which secure their water from Lake Winnebago and the Fox River.

• • •

Large Irrigation Storage

AN ALL-TIME high in storage of water for irrigation in reservoirs of the U. S. Bureau of Reclamation recently was announced by John C. Page, Commissioner of Reclamation. On June 1, 1937 the total figure was 23,670,106 acre-ft. as compared to 16,288,258 acre-ft. on June 1, 1936. More than 4,000,000 acre-ft. was added to the storage in the month of May. "Generally, this is a good water year in the west," Mr. Page said, "and the irrigation districts are assured of good crops."

• • •

Construction in Peru

PERUVIAN construction work, both governmental and private, is continuing at a high rate, with prices of structural materials showing an upward trend and public funds in considerable amounts being devoted to highway development work.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

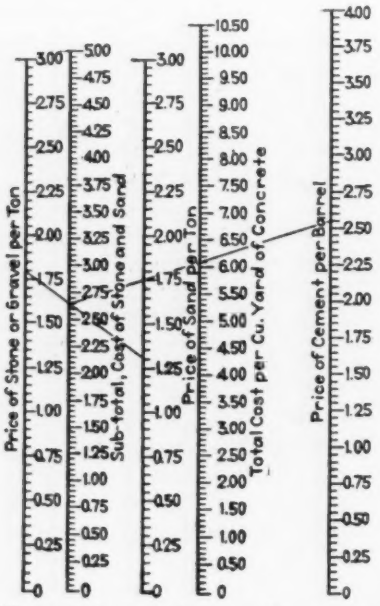
Graph for Cost of Concrete

by EMMONS W. DEBERARD and MORRIS PODOLSKY

The Sanitary District of Chicago, Chicago, Ill.

In a given mix of concrete the relationship between the quantities of stone, sand and cement varies but little—for a 1:2:4 mix the approximate quantities are: Cement, 1.35 bbl; sand 0.40 cu.yd. and stone, 0.80 cu.yd. As the prices for sand and stone are given per ton, the following relationships are used: Sand, price per ton multiplied by 1.5 equals price per cu.yd. and stone, price per ton multiplied by 1.3 equals price per cu.yd.

The nomograph has been constructed on these bases. It gives a


Price of Stone or Gravel per Ton
Sub-total, Cost of Stone and Sand
Price of Sand per Ton
Total Cost per Cu. Yard of Concrete
Price of Cement per Barrel

Nomograph gives direct reading of concrete cost.

ready and accurate estimate of the cost of materials per cubic yard of concrete without the necessity for calculating. The following is an example of the use of the nomograph: from the *Engineering News-Record* we find that in a given locality the prices of stone and sand per ton, and of cement per barrel are $1.80, $1.30 and $2.55, respectively. Draw a line between $1.80 on the first scale from the left and 1.30 on the third. The line intersects the second scale at 2.65. Now connect this point with 2.55 on the last scale. This new line will intersect the fourth scale at 6.09, which is the cost of materials per cubic yard of concrete at the given prices. Similar charts may be constructed for a 1:2:3 mix, a 1:3:5 mix or for any other mix which is continually being used.

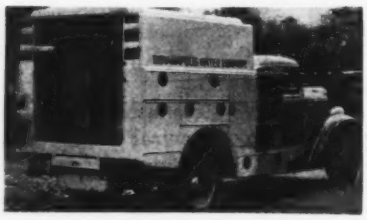
• • •

Service Maintenance Truck With Air Compressor

by H. S. MORSE

Manager, Indianapolis Water Co., Indianapolis, Ind.

A new service maintenance truck which has just been placed in operation by the Indianapolis Water Co., carries an air-cooled compressor of sufficient capacity to run two paving breakers, or tools of equal capacity, and a fitted steel body designed to carry all equipment necessary for a crew which specializes in the maintenance of and replacement of customer services from the main to the property line. Cabinets are provided for all tools including one large cabinet for a 2-in. ditch pump. A folding bench on the inside provides a place for the men in the crew to ride. The air compressor is mounted in fairly close quarters between the cab and the truck body. An opening in the front end of the truck body allows access to the compressor engine for carburetor and other minor adjustments. The compressor is equipped with lifting bail and for major repairs the unit will be unbolted from the frame and lifted off by the overhead hoist in the repair shop, allowing the truck to go back in service using a trailer compressor.



Service maintenance truck with compressor unit.

• • •

Curve Computation Shortcuts

By W. B. HOGAN

Babylon, N. Y.

The simple formulas that follow will help in running highway curves when tables of chord lengths are not at hand. The chord correction, that is, the number of feet to be subtracted from the theoretical length of arc to find the chord to be measured, is nearly equal to .00127 of the length of the curve in hundreds of feet times the square of the central angle in degrees and decimals of a degree.

$$\text{Chord} = L - \left(.00127 \times \frac{L}{100} \times I^2\right)$$

This formula is correct to better than $\frac{1}{20{,}000}$ for central angles up to 30 deg.

Just as while chaining in very hot or very cold weather one calculates the temperature correction mentally as .01 ft. every 15 deg. F., away from the chain standard, so one can figure in his head the chord correction for 100-ft. arcs, in hundredths, as $\frac{(\text{Degree of curve})^2}{8}$ The error from this formula is less than one-half hundredth for degree-of-curve up to 16 deg. Similarly the correction for 50-ft. arcs is about $\left(\frac{\text{Degree of curve}}{8}\right)$

A quick way to find the length of any plotted circular curve turning less than a right angle is to locate by eye a point near the middle and scale the distances to it from both ends. To the sum of these distances add one-third the difference between that sum and the length of the full chord between the ends. This gives the length of arc as closely as it can be scaled.

To lay off a given arc length on such a curve: Suppose the problem is to lay off 587 ft. on a 1000-ft. radius curve. Mark off say a 290-ft. chord *a* from the starting point and then another 290-ft. chord, for the trial point; and measure from the starting

point to the trial point the full chord which will be close to 574-ft. for this radius. Then this trial arc length is

$$8a - \frac{c}{3} \text{ or } \frac{(8\text{x}290) - 574}{3} = 582 \text{ ft.}$$

and 5 ft. more to be scaled off, for the desired arc length.

Another method for finding the length of a circular curve involves a little more computation, but is exact enough to use with an accuracy of $\frac{1}{20{,}000}$ for field curves having a central angle less than 45 deg. Measure the full chord c and the middle ordinate m. Figure the chord for half the arc $a = \frac{\sqrt{c^2 + m^2}}{4}$. The length of arc

$$L = \frac{8a - c}{3} \text{ or } L = \frac{(4\sqrt{c^2 + 4m^2}) - c}{3}$$

To find the accurate plus and offset of a point such as a property-line monument from an established base line without a transit, measure the distances a and b to the point from the two nearest 100-ft. stations on line. If the distance from the back station (a) is the greater the plus

$$x = \left(\frac{a+b}{100}\right)\left(\frac{a-b}{2}\right) + 50$$

if it is the smaller

$$x = 50 - \left(\frac{b+a}{100}\right)\left(\frac{b-a}{2}\right)$$

The offset $y = \sqrt{a^2 - x^2}$ or as a check $y = \sqrt{b^2 - (100 - x)^2}$.

. . .

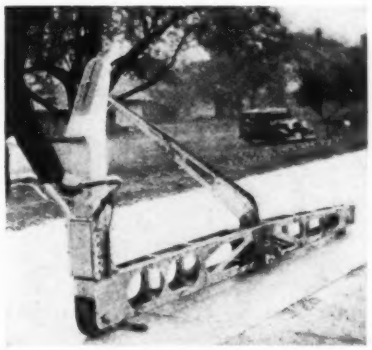
Brief Memorandum

For something over a year the Denver water department has been using ammonium sulphate in lieu of anhydrous ammonia, in forming chloramine for the treatment of the effluent from the filter plant. On the Denver market anhydrous ammonia is $0.21 per lb., but ammonium sulphate can be obtained from a neighboring steel mill at $0.018 per lb., being produced as a by-product in the coking plant. The ammonium sulphate contains about 25 per cent ammonia, making the cost of a pound of ammonia $0.072. A dry feed machine is used to deliver the ammonium sulphate into the filter effluent at a point just above the place of application of the chlorine.—D. D. Gross, *Chief Engineer, Denver Municipal Water Works, Denver, Colo.*

Road Surface Checked to Accuracy of 0.001 in.

The surface-testing device illustrated is used by the Oregon State Highway Department. The Oregon requirement is that irregularities shall not exceed 0.07 in. in 10 ft. The machine indicates variation to one-thousandth of an inch, is constructed of a light aluminum alloy and has a total weight of about 150 lb. It consists of a framework on two rubber-tired wheels exactly 10 ft. on centers with a third rubber-tired wheel midway between the other two. The third wheel operates freely in a vertical direction on a 23-in. lever arm; irregularities in the pavement cause the third wheel to move a counterbalanced magnifying arm which actuates an indicator on a scale graduated to read road surface variations of 0.001 in. The scale is placed where it can be seen easily by the operator while the machine is in motion. The device has connections for attaching (1) a recording drum which will make a graph of the pavement surface and (2) a cumulative dial which totals surface variations in inches for the entire distance traveled on the road.

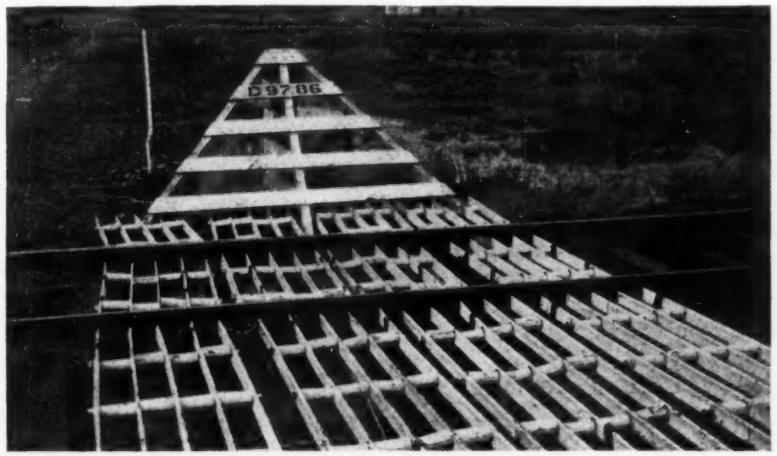
One man operates the machine and, wherever a high point is found, a mark is made on the pavement beside the third wheel. This is done by a jumbo crayon mounted in such a way that a lever controlled by the operator



Surface variations of 0.001 in. indicated by this device.

can bring it into contact with the pavement whenever desired.

The device is called a "planometer" and was developed by W. H. Muirhead of the Beaver-Portland Cement Co., Goldhill, Ore. R. H. Baldock, Salem, Ore. is state highway engineer.



New Type Cattle Guard

A new type of cattle guard in which the bars are placed transversely instead of parallel with the rails is being tried out on the Denver & Salt Lake (Moffat) Ry. The guard, as shown in the accompanying illustration, is simply an assembly of old boiler tubes, smashed flat and held in upright position by pipe spreaders and bolts. The bars are spaced 6 in. apart, which is wider than is the usual practice. Experience has shown that the wide spacing and transverse arrangement discourage stock from attempting to cross the barrier, and if the animal insists on crossing, the guard will not trap or injure it. The new guard was designed by W. C. Jones, chief engineer, after talking with veteran stockmen, and has proved effective in keeping stock off the right-of-way.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Fluid Mechanics

FLUID MECHANICS—By R. A. Dodge and M. J. Thompson. 495 pp. Published by McGraw-Hill Book Co., New York and London. Price $4.

The authors of this new text on hydraulics, who teach in the University of Michigan, were keenly aware of the paucity of organized material relative to fluid mechanics and have made an excellent effort toward amelioration of this situation. The arrangement of the book follows the logical pattern of developing first the fundamental principles governing both liquid and gaseous fluids, and following this with specific applications in theory and, to some extent, in practice in hydraulics and aerodynamics.

Many competent practical engineers have doubtless been hazily aware that nomenclature in "hydraulics", as fluid mechanics was called in their college days, has been changing: that widespread and intensive study of theory of fluids, static and in motion, and the reconciliation of theory with experimental facts during recent decades have created means for more accurate forecasts of performance and consequent design economies. These engineers will find in this book thorough opportunity for clarification of their thinking in matters hydraulic, and for modernization of their technique.

Chapters on dynamic lift and propulsion, having to do with theory of airplanes, and on dynamic similarity, covering model studies of hydraulic structures and of airplanes, will be of interest to those who have not yet had occasion to utilize these newer scientific tools of predetermination of the results of their designs.

In this connection one competent teacher, with whom the book was discussed, agrees that the presentation is logical except that the major fundamental principles—the continuity principle, the law of conservation of energy and the momentum principle—should be followed directly by the discussion of dynamic similarity. That is, Chapter XV following Chapter VI would allow the intervening chapters using the Reynolds number to seem more real. He adds, "One other opportunity for enhancing rational treatment and physical understanding which the authors have missed is the use, in Chapter IX, of the well known graph of log V versus log F entitled "Flow of Fluids in Pipes". If this and the basic formula $F = \frac{Constant}{N_R{}^{(2-n)}}$ were included, more rational explanation of the various particular expressions for f would be possible.

The only other possible weakness this teacher mentioned was that greater emphasis upon the importance of pressure under the nappe of weirs, and Bazin's resultant classification of weirs into six types, would provide better understanding of the physics of flow over weirs and hence a more rational understanding of their properties and uses. It was declared, however, that the book is really a notable advance in the transition from "hydraulics" to "fluid mechanics", from the era of empiricism to a more rational one.

The primary purpose of the book is that of a text, and the range of material covered is so great that it was impossible to include tables and the specific applications which an hydraulic or an aeronautical engineer might desire in a "handbook". However, both for the student's and the engineer's convenience, it is suggested that in future editions a schedule of symbols with definitions and reference to page of first usage be included. *Reviewed by* L. J. Bevan, *consulting engineer, New York City.*

Foundation Data

SOME DATA IN REGARD TO FOUNDATIONS IN NEW ORLEANS AND VICINITY—Collected and Compiled by the Soil and Foundation Survey, a project of the Works Progress Administration of Louisiana. 277 pp. Published by the Works Progress Administration of Louisiana, New Orleans, La.

At the suggestion of the Louisiana Engineering Society, the Works Progress Administration has compiled data on foundations in and near New Orleans, and has now published them in a large volume entitled "Some Data in Regard to Foundations in New Orleans and Vicinity", briefly noted in *ENR* July 29, p. 201. So far as is known to the writer, no similar work has been done in any other community, and it seems certain that engineers, architects and builders in other areas would derive advantage from similar compilations in their vicinities.

The foundation conditions in and near New Orleans present many problems which are not always easy to solve, and the assembling of data to show what has been done must prove of value to all designers and builders of the region.

The volume is put together in logical order. Historical and geological information are followed by data on borings and stratigraphs fairly well covering the entire area; then come pile foundation data for a number of structures and similar information on spread footings.

Some observations of settlements or subsidiences are given but it is to be regretted that more were not available. The data will, however, be useful at least to indicate the character of plans which have been used in the past for the support of structures which have not failed, though many of them must surely have settled or subsided to some probably small but unknown extent.

In the introduction to the chapter on pile foundations occurs the following statement: "Each case is a study in itself. It seems customary to design pile foundations for a total combined load of 12 to 15 tons per pile, while tests that have been made and buildings which have stood without settlement indicate that much heavier loadings could be made with safety." With the latter part of this statement the writer cannot wholly agree, and if taken too literally, trouble may follow.

It is known that every pile supported building thus far observed instrumentally shows some settlement. It is also known that where the piles under a given structure have unequal loadings the settlement has not been uniform, and that the more heavily loaded piles settle more than adjacent piles less heavily loaded. The relative supporting capacity of individual piles and of piles in clusters has not been definitely fixed, nor has the best spacing of piles in clusters been satisfactorily determined. We are also more or less in the dark

as to whether piles in this vicinity are wholly friction piles or partly bearing piles, and, if the latter, to what extent.

It is believed by some, the writer among the number, that when piles are driven in clusters the cluster is the unit and not the individual pile, and that therefore the test driving and test loading of an individual pile does not provide in itself a factor which may safely be used in determining the load per pile in clusters or the number of piles to support a given load. The information obtained from the test driving and test loading in this vicinity seems to this writer to be useful principally as a source of information as to the compactness or looseness of the soil, the depth and thickness of denser or more compact strata, and generally for comparison with other locations in which structures erected after similar test driving and test loading have not failed or have settled uniformly to a limited extent.

The lack of uniformity in the reaction of piles for foundations in this vicinity is evidenced by the fact that the writer knows of a few structures which transmit a combined load of from 18 to 20 tons per pile without disturbing settlement, and others in which under a load of 10 tons there has been settlement of from 6 to 8 in. What is true of pile foundations in and near New Orleans is also true of spread footings; in some places the soil has carried and is carrying from 2,000 to 2,500 lb. per sq. ft. without disturbing or unequal settlement, while in others a load of 600 lb. per sq. ft. has created marked and irregular settlement.

With full recognition of the value of this volume the writer is convinced that it is no "Vade Mecum" from whose pages the answer to foundation problems may be quickly read—*Reviewed by* J. F. COLEMAN, *Consulting Engineer, New Orleans.*

Drainage and Sanitation

DRAINAGE AND SANITATION — By E. H. Blake, revised by W. R. Jenkins. 5th edition. 563 pp. Published by by B. T. Batsford, Ltd., London. Price, 15s.

This book is a complete treatise on British practice and deals in detail with conditions vital to healthy buildings and their surroundings. It includes chapters on environment of the building, its planning and construction; prevention of dampness; ventilation, heating and lighting. The section on water-supply traces water from its source to the mains in the streets, and the arrangement of hot and cold services in buildings. Sanitary drainage of various kinds of buildings and a symposium of sewage disposal methods are also included. Completing this comprehensive coverage are chapters on refuse disposal, street cleaning, disinfection, and smoke abatement; special attention is given to a review of English statutory enactments governing sanitary matters.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

METHODS OF READJUSTING LOCAL GOVERNMENT SERVICES and areas for greater efficiency and economy are outlined in Pocket Report Series No. 3, issued by the Princeton Local Government Survey, Princeton, N. J.

TRAINING PUBLIC EMPLOYEES to do a better job—a review of present methods and proposals for future developments—is discussed in the report "Toward Competent Government," distributed by the American Municipal Association, 850 East 58th St., Chicago, Ill.

HOUSE TRAILERS, Their Effect on State and Local Government, is the subject of revised report No. 115, issued by the American Municipal Association, 850 East 58th St., Chicago. Price 50 cents.

MOSQUITO CONTROL DATA and progress throughout the world during the past year is recorded in the comprehensive proceedings of the 24th Annual Meeting of the New Jersey Mosquito Extermination Association. Copies at 75 cents each may be obtained from Dr. T. J. Headlee, Rutgers University, New Brunswick, N. J.

WELDING PROCEDURE is covered in two recent booklets, one entitled "The Hobart Art Welding Manual and Operator's Training Course," put out by Hobart Bros. Co., Troy, Ohio, which sells for 50 cents, and one entitled "Design of Welded Piping" published by the Linde Air Products Co., 30 East 42nd St., New York. The latter replaces a pamphlet entitled "Design Standards for Oxwelded Steel and Wrought Iron Piping" first published in 1929. The booklet is free to interested parties.

DEVELOPMENT IN ROAD STABILIZATION is the subject of a bulletin published by the Engineering Extension Department of Purdue University of Lafayette, Ind. as Extension Series No. 38.

PIPE MATERIALS for sewers, a series of articles by Hugo Bronneck, civil engineer for the building department, Vienna, is the title of a bulletin translated from the German and distributed by the Clay Products Association, 111 West Washington St., Chicago, Ill.

THE PRICE of "Filtration Materials for Sewage Treatment Plants," a publication of the American Society of Civil Engineers, was incorrectly given in our issue of June 24, p. 961, *as 50c to non members.* It should be 60c.

NEW PUBLICATIONS

AIR CONDITIONING IN THE HOME—A treatise for Engineers, Architects and Home Owners—By Elmer Torok. 296 pp. Published by The Industrial Press, New York, and The Machinery Publishing Co., Ltd., London. Price $3.

THEORY OF ALTERNATING CURRENT MACHINERY—By Alexander S. Langsdorf. 788 pp. Published by McGraw-Hill Book Co., New York and London. Price $6.

DELTA, ESTUARY, AND LOWER PORTION OF THE CHANNEL OF THE COLORADO RIVER, 1933 to 1935. By Godfrey Sykes, 70 pp. Published by Carnegie Institution of Washington, Washington, D. C.

STRUCTURAL ENGINEERING PROBLEMS—Dealing with Frames, Wind Bracing, Retaining Walls, Sheet Piling, and Wave Pressure on Breakwaters. By David A. Molitor. 155 pp. Published by David A. Molitor, 1445 Spring Road, N. W., Washington, D. C. Price $2.75.

THE SCIENCE OF VALUATION AND DEPRECIATION—By Edwin B. Kurtz. 221 pp. Published by the Ronald Press Co., New York. Price $4.50.

THE VALUATION OF PROPERTY — A Treatise on the Appraisal of Property for Different Legal Purposes—2 Vols. By James C. Bonbright. 1,271 pp. Published by McGraw-Hill Book Co., New York and London. Price $12 per set.

ACCOUNTING PRINCIPLES FOR ENGINEERS—By Charles Reitell and Clarence Van Sickle. 518 pp. Published by McGraw-Hill Book Co., New York & London. Price $4.

MORE SECURITY FOR OLD AGE—By the Committee on Old-Age Security of the Twentieth Century Fund, Inc. 191 pp. Published by Twentieth Century Fund, Inc., New York. Price $1.75.

THE WEEK'S EVENTS

Continued from page 335

Wide World Photo

FRASER RIVER BRIDGE UNDER CONSTRUCTION

CONSTRUCTION work is under way on the arches for the highway bridge across the Fraser river at New Westminster, B. C., which is on the main artery for automobile traffic between Seattle and Vancouver. The bridge will carry a four-lane highway.

Contractors for the bridge, which is being built by the British Columbia department of public works, are the Dominion Bridge Co., Ltd. W. G. Swan, Vancouver consulting engineer, is consultant on the project.

The old low bridge which the new structure will replace can be seen behind the arches.

Plans Adopted for School At New London

Plans for a new school building at New London, Texas, to replace the structure destroyed in a gas explosion last March which took more than 300 lives (*ENR*, March 25, 1937, p. 459) have been adopted by the New London Independent School District. Extreme precaution against a repetition of the disaster has been taken in the plans for the new $300,000 structure.

The E-shaped building, 280 ft. by 150 ft. in plan, is divided into sections, the junior high school and the senior high school, and an auditorium in the center of the structure serving both schools and separating them. It will be of reinforced concrete construction with solid brick exterior walls and solid gypsum-block interior partitions. The first-floor slab will be placed on an earth fill, leaving no dead air space under any portion of the building. The structure is two stories high.

Heating for the new building and for all the present buildings on the campus will be provided from a central steam plant located in a separate building placed in the center of the campus. There is to be no gas piping in the new buildings except that which is necessary to serve the laboratories, and this extends only from the outside walls of the buildings to the desks.

The new building will contain nineteen classrooms, three laboratories, four shops, two study halls, two libraries, and separate office suites for each of the two schools.

• • •

New Research Body Formed By Rail Association

A division of engineering research has been formed by the Association of American Railroads to expand and unify the research activities of the railroads of the country. The department will absorb the division of equipment research organized several years ago. L. W. Wallace, head of the old department, will become director of the new division and G. M. Magee, assistant engineer of the Kansas City Southern Railway, will be assistant director.

The scope of the new division is intended to be wide enough to bring under one head all research activities having to do with mechanical, civil and electrical engineering and also those dealings with problems so closely related to each of these branches that there would be duplication of effort if each branch were handled separately. The division, it was announced, will neither duplicate nor replace the activities of the research departments of the various railroads, but will supplement those activities.

Big Power Development On St. Maurice River

A new water-power development is scheduled to go into construction during the coming winter on the St. Maurice River, Quebec, which is already one of the most important power sources in the Dominion of Canada. The new plant, which will be located near Latuque, will be constructed by the St. Maurice Power Corp., Ltd., a subsidiary of the Shawinigan Water & Power Co., Ltd., and will have an initial capacity of 162,000 hp. It will consist of four units of 40,500 hp. each, operating under a head of 104 ft. Foundations will be installed for two additional units which may be placed in the future. The engineering and construction work will be done by the Shawinigan Co. and its subsidiaries.

The Quebec Electricity Commission has approved the project.

About half of the power generated will be used by the Brown Corp. in its plant at Latuque. The rest of the output will be taken by Shawinigan Co. into its transmission system, which covers much of the Province of Quebec.

This development is one of a number of plants planned on the St. Maurice, the preliminary locations of which have been fixed by a comprehensive survey of the river conducted a few years ago by the Shawinigan Co. Future developments of the upper reaches of the river, therefore, will be under a coordinated plan.

• • •

Filters for Septic Tanks Required at St. Louis

Installation of filters wherever septic tanks are employed as a means of sewage disposal for new buildings is required under an amendment which has been added to the St. Louis county, Missouri, plumbing code by the county court of St. Louis county. Septic tanks are widely used in unincorporated areas of the county. The filters contemplated in the amendment will add $20 or $25 to construction cost.

The amendment was accepted by the court on recommendation of the county health commissioner, who said that the influx of people into the county is in excess of the ability of unincorporated areas to build needed sewers, making necessary the use of septic tanks and filters.

The amendment also provides that the county plumbing board, consisting of the court and the health commissioner, can require installation of filters at existing homes with defective septic tanks.

Wide World Photo

NEW WATERLOO BRIDGE GETS UNDER WAY

WORK has started on the new Waterloo bridge across the Thames river in London with award of the contract to Peter Lind & Co., Ltd., on its low bid of about $3,350,000. The contract allows for increases due to advances which may occur in the cost of materials or labor.

The bridge, 80 ft. wide, will carry six lanes of traffic, with a 4-ft. separating strip between opposing lanes, and two 11-ft. widewalks. It will consist of five spans of about 238-ft. each.

Outstanding characteristics of the design is the wide span and shallow rise of the arches. Each span will consist of twin arches side by side, with a flat soffit, 33 ft. wide, between them. The arches and the flat soffit will be of reinforced concrete with the spandrels faced with portland stone. The piers will be faced with granite up to a level slightly above high water mark and the upper portion will be faced with portland stone. A molded parapet of portland stone will be surmounted by a light bronze balustrade with bronze lamp standards.

The bridge was designed by Sir Giles Gilbert Scott.

Housing Rentals Announced On Oklahoma Project

Rentals on Will Rogers Court, $2,000,000 PWA low-rent housing project in Oklahoma City, will range from $14.10 to $22.10 per month, it has been announced. Two-room units will rent for $14.10; three-room units for $17.40; four-room units for $20.40 and five-room units for $22.10 per month. Utility charge will range from $3.85 to $5.45 per unit per month.

Will Rogers Court consists of 85 fireproof buildings grouped around court areas and containing 354 dwelling units.

• • •

States Spend Billion On Highways

State highway departments received $1,145,590,000 for highway purposes during the year 1936 and expended $1,131,151,000 in the same period, according to an announcement made by the U. S. Bureau of Public Roads.

The income received represents an advance of $243,580,000 over the preceding year. Of this income, $663,886,000 was produced by payments from highway users in the form of taxes and tolls. Federal funds received amounted to $346,281,000; $106,235,000 was derived from the sale of bonds and notes; $14,447,000 was received from counties and other local sources; and $14,741,000 was appropriated from general funds or derived from miscellaneous sources.

The expenditures were divided into $607,284,000 for construction and $219,202,000 for maintenance. Other expenditures for equipment, administration, state police and interest on highway debt brought the total expenditure for state administered highways to $947,085,000. Retirements of bonds amounted to $79,171,000, and $104,895 was transferred for use on local and park roads or was used for non-highway purposes.

• • •

Centrifugal Dewatering Planned at Twin Cities

The board of trustees of the Minneapolis-St. Paul sanitary district on Aug. 9 decided to employ centrifugal dewatering of ground screenings.

The quantity of screenings is expected to range from 4,100 to 8,200 lb. of dry solids daily mixed with from 15,000 to 35,000 gal. of water. Dewatering will be done with the centrifuge of the American Centrifugal Corp.

Name of Casper-Alcova Changed to Kendrick

The Casper-Alcova project under construction by the Bureau of Reclamation in Wyoming was renamed the Kendrick project with the enactment of the Interior Department appropriation bill for 1938, in memory of the late Senator John B. Kendrick of Wyoming. Senator Kendrick was for 30 years a strong proponent of the project now named for him and from 1920 until 1933 he carried on an active campaign to have it approved. Although the Senator lived to see approval of the project and allotment of PWA money, he died before construction began. It has been the policy of the Department of the Interior to discourage naming of projects of the Bureau of Reclamation in honor of men who are still living.

The Kendrick project consists of Seminoe Dam on the North Platte River about 60 miles southeast of Casper, the Alcova diversion dam, and the Casper Canal, which extends from the diversion dam to a point near Casper, where 35,000 acres of land will be irrigated. All the major features of the project are now under construction and the project as a whole is about 35 per cent complete.

OBITUARY

EDWARD B. HAROLD, 49, a retired construction engineer, died in Newark, N. J. Aug. 6.

HERBERT A. ARMSTRONG, a retired bridge contractor, died at Barrington, R. I., Aug. 9 at the age of 64. He had been in business in Providence for many years and was at one time a member of the firm of Milligan & Armstrong.

ALEXANDER G. MCKENNA, chairman of the board of directors of the Pomona Pump Co., Pomona, Calif., died in Pasadena July 29 at the age of 72. Mr. McKenna had held various positions in the steel industry before he purchased the Pomona Pump Co. in 1923.

CARL F. STOLTZ, signal engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., died in Cincinnati on Aug. 6, aged 51. Mr. Stoltz had been connected with the engineering department of the C.C.C. & St. L. since 1906. He was made assistant signal engineer in 1912 and promoted to signal engineer in 1913, which position he held until his death.

FRANK A. MCINNES, for the past ten years a consulting civil engineer at Boston, Mass., and for many years previously connected with the city water, sewerage, and public works departments there, died at Boston Aug. 9 at the age of 80. Before his service with the city, Mr. McInnes was for ten years engaged in railroad engineering in this country and Canada.

ERNEST FUSEY, who retired five years ago from his position as superintendent of the Montreal department of sewers, died in Montreal July 31 at the age of 74. Mr. Fusey was a graduate of L'Ecole Polytechnique in 1890. From the time of his graduation until 1906 he served with the engineering departments of the Canadian federal government and joined the staff of the city of Montreal in the latter year, remaining with the city for the rest of his career.

JAMES L. KIMBROUGH, organizer and first president of the American Institute of Steel Construction, died July 9 at the age of 57. Mr. Kimbrough was continuously connected with the institute from the time of its organization until last January, when he relinquished his duties due to ill health. After his graduation from the Lawrence Scientific School of Harvard, in 1901, Mr. Kimbrough joined the Indiana Bridge Co., becoming treasurer in 1904 and succeeding his father as general manager in 1913. He became president of the concern in 1932.

New Architectural Building Planned at M.I.T.

Plans have been announced for a new School of Architecture Building at the Massachusetts Institute of Technology, part of the institute's original plan for gradual expansion.

Immediate construction of the new building was made possible by the sale of the former site of M.I.T. in Boston. The new school will cost about $1,400,000 and is scheduled to be completed in September, 1938.

The school will be a 4-story building conforming to the style of the rest of the institute. It will be of limestone fronted by a broad flight of steps and a colonade and surmounted by a dome.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

CANADIAN GOOD ROADS ASSOCIATION, annual convention, St. Andrews-by-the-Sea, N. B., Sept. 7-9.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Boston, Sept. 27-30.

AMERICAN PUBLIC WORKS ASSOCIATION, annual conference, Atlanta, October 4-6.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, New York, Oct. 5-8.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, Scranton, Pa., Oct. 11-13.

NATIONAL SAFETY CONGRESS, Kansas City, Oct. 11-15.

AMERICAN WELDING SOCIETY, annual meeting and exposition, Atlantic City, N. J., Oct. 18-22.

CANADIAN INSTITUTE OF SEWAGE AND SANITATION, annual convention, London, Ont., Oct. 21-22.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual convention, White Sulphur Springs, W. Va., Oct. 27-29.

REGIONAL AND LOCAL

SECTION MEETINGS, AMERICAN WATER WORKS ASSOCIATION: New York, Schenectady, Sept. 30-Oct. 1; Rocky Mountain, Santa Fe, N. M., Sept. 20-22; Southwest, Austin, Tex., Oct. 18-21; California, Sacramento, Oct. 20-23; Minnesota, St. Paul, Oct. 28-30.

MONTANA BITUMINOUS CONFERENCE, annual conference, Glacier National Park, Sept. 7-9.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, Poland Spring, Me., September 21-24.

ROCKY MOUNTAIN SEWAGE WORKS ASSOCIATION, first annual meeting, Santa Fe, N. M., Sept 20-23.

PERSONAL

JOHN A. PETSCHE recently resigned his position as city engineer of Garfield Heights, Ohio.

RENE CARLE, has been appointed assistant chief divisional engineer of the Quebec Department of Roads.

HAROLD W. BAKER of Rochester, N. Y., has been enrolled as a lieutenant commander in the Navy Civil Engineer Corps.

JOHN H. HECKATHORN of Fort Peck, Mont., has been appointed lieutenant, junior grade, in the civil engineer corps of the U. S. Navy.

CALLIS H. ATKINS of Raleigh, N. C., has been enrolled as a lieutenant, junior grade, in the Navy civil engineer corps.

EARL R. BENNETT of Los Angeles, has been enrolled as a lieutenant, junior grade, in the Navy civil engineer corps.

RAYMOND B. KRUM, Washington, D. C., has received an appointment as lieutenant, junior grade, in the civil engineer corps of the U. S. Navy.

T. S. O'CONNELL, state engineer of Arizona, has been appointed chairman of the committee on international highway relations of the American Association of State Highway Officials.

COMMDR. EDWARD L. MARSHALL of the Navy civil engineer corps has left his position at the naval operating base in San Diego and is now in the Navy Department Bureau of Yards and Docks at Washington, D. C.

MAJ. A. C. LIEBER, JR., who has been an engineer of the Dover area, U. S. Engineers, in the Muskingum Watershed Conservancy District, has been transferred to the general staff school at Fort Leavenworth, Kan.

JOHN C. WIDENER has been appointed hydrographic engineer for the Maryland State Conservation Commission. He was formerly connected with the U. S. Engineers and had charge of a number of surveys in the Maryland district.

A. B. HENNING has taken a position with the Port of New York Authority as assistant engineer on construction of the Midtown (Lincoln) Hudson tunnel and approaches. Mr. Henning was formerly a project engineer with the U. S. Bureau of Public Roads on location and construction of the skyline Parkway in North Carolina and Virginia.

E

RAW-

I

eerin

rary

I